OPERATION AND SERVICE MANUAL

ROD-L M100/M500 HI-POT TESTER

Manual Part No. 90001

codex
corporation
20 CABOT BOULEVARD, MANSFIELD, MASSACHUSETTS 02048

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ROD-L ELECTRONICS, INC.
1098 HAMILTON CT. • MENLO PARK, CALIFORNIA 94025 • (415) 322-0711

CERTIFICATION

ROD-L certifies that this instrument was thoroughly inspected and tested and found to meet its published specifications when it was shipped from the factory.

WARRANTY AND ASSISTANCE

All ROD-L Electronics' instruments are warranted against defects in materials and workmanship. This warranty applies for one year from date of delivery to the original purchaser. We will repair or replace instruments which prove to be defective during the warranty period provided they are returned to ROD-L Electronics.

For prompt, efficient service of your instrument, send it directly to ROD-L Electronics along with a statement describing the nature of the problem.

A Return Authorization Number must be obtained from ROD-L Electronics before returning any instruments for repair. Transportation must be prepaid. ROD-L Electronics will assume cost of surface transportation when returning equipment to customer. This warranty is void if the instrument has been modified or subject to gross misuse. No other warranty is expressed or implied. ROD-L Electronics is not liable for consequential damages.

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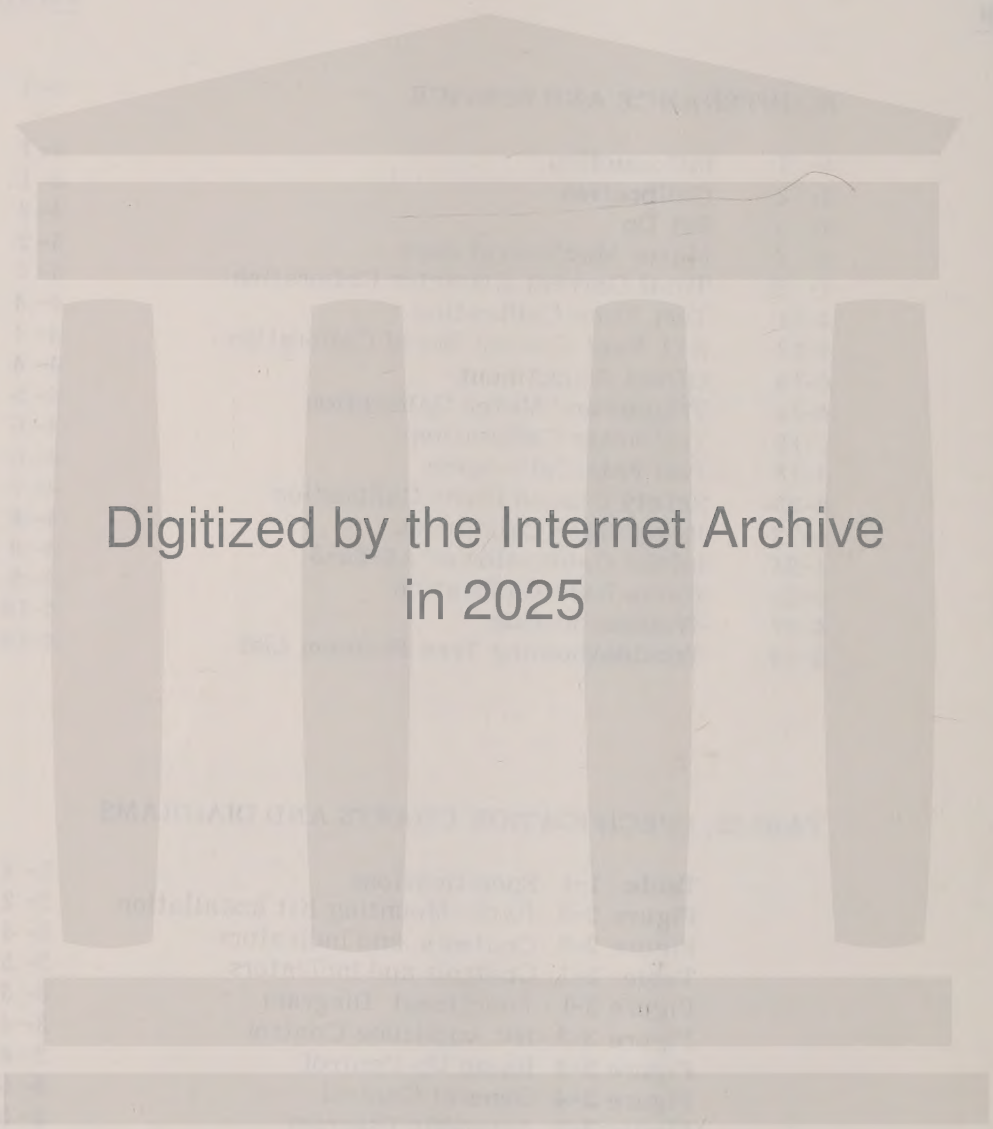

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INTRODUCTION

Section I

1-1 General

1-2 This publication, which provides operating and servicing instructions for the ROD-L Electronics Models M100AV, BV and M500AV, BV AC Hipot Testers is divided into five sections. Section I describes the Instruments and lists their specifications. Section II contains Installation Instructions and Operation Procedures. Section III contains Principles of Operation. Section IV contains Service Instructions. Section V contains Replacement Parts Information, Parts Location Diagrams and Schematics.

1-3 Models M100, 500, AV, BV AC Hipot Testers are high voltage leakage and breakdown testers with safety ground continuity test capability for performance of "dielectric withstand" tests in accordance with applicable UL, CSA, VDE, BSI, IEC and similar standards. The M100AV, 500AV tests and displays total current, while the M100BV, M500BV tests and displays total current and the resistive part of the AC current.

1-4 The "dielectric withstand" test is one of many tests required by many certification agencies (UL, CSA, VDE, BSI, IEC, etc) as proof of an instrument's ability to withstand AC power line spikes without becoming a hazard to itself or the user. For example, lightning, drastic load changes or power line outages can place short duration spikes on power lines of many times nominal line voltage.

1-5 Some specific examples of safety standards requiring dielectric withstand testing include UL 45, UL 114, UL 478, UL 506-508, UL 544, UL 674, UL 1012, UL 1244, IEC 380, IEC 348, MIL,STD 202, BSI 3361 as well as CSA 22.2, VDE 0806, etc. The specific standard should be consulted for voltage requirements and specific test procedures.

1-6 The ROD-L AC Hipot Testers apply high voltage to the device under test for a duration of time preset for one second to 90 seconds. The device under test plugs into the front panel test connector. Test limits for total current (and for Resistive part of the AC current with BVs) are preset by the user via a rear panel control. If the device under test is defective, automatic circuitry turns off the high voltage, lights the FAIL lamp and sets off an audible alarm. This audible and visual alarm must be manually reset (meets UL requirements).

1-7 All models incorporate a rapid, automatic solid state electronic shutdown circuit to turn off the high voltage within two milliseconds after a fault. To prevent turn-on surges, the high voltage has an electronically controlled rate-of-rise.

1-8 For operator use, the test cycle is fully automatic; accidental test initiation is prevented by use of a recessed start switch. For operator safety, a second security "CHASSIS GROUND" must be connected to a secure low resistance point on the device under test. Without this connection, the tester will not enter the "READY" state. Both the security "CHASSIS GROUNDS" and the "SAFETY GROUND" of the device under test are monitored and stressed electronically. If either ground fails during the test, the Hipot Tester automatically shuts down the high voltage and actuates visual and audible alarms.

1-9 The **ROD-L** AC testers are completely self contained rugged instruments designed for laboratory and production testing environments. All AC units are very similar in operation and construction. The primary exception is the BV model measures the resistive part of AC total current. Externally, the BV has an extra control on the front and rear panels (see Figure 2-2). Internally, the BV has 5 plug-in PCB assemblies (A2-1, A6-S5-3, A7, A10, A21) and the AV has four plug-in PCB assemblies (A6-S5-3, A7, A10, A21). Assemblies A7, A10, A21 are interchangeable.

1-10 EQUIPMENT SUPPLIED

1-11 The **ROD-L** Hipot Tester is comprised of the following:

a. Hipot Tester, **ROD-L** Model M100AV, M100BV, M500 AV or M500BV.

b. Six foot power cord, three pronged.

c. Thirty-six inch (36") ground cable.

d. This manual.

e. Extra input line fuses.

1-12 STANDARD VERSIONS OF MODELS

The standard AC Hipot Tester is available with a full scale test voltage of 1500 VAC, 2800 VAC or 5000 VAC. Ammeters with F.S. up to 333mA are available depending on the Model. Standard F.S. values for the ammeter are 10, 25, 40, 50, 100, 200 and 333mA. For the M100 models the maximum F.S. values are 50mA for the 1500 VAC unit, 40mA for the 2800 VAC and 25mA for the 5000 VAC. For the M500 Model the maximum F.S. values are 333mA for the 1500 VAC 100mA for the 2800 VAC and 100mA for the 5000 VAC.

1-13 SPECIAL VERSIONS OF MODELS

Instruments with non-standard test voltages and ammeters are considered special versions of the basic models. In these applications, the customer specifies the voltage and ammeter full scale values. The Hipot Tester high voltage F.S. rating and the ammeter F.S. rating are readable from the Model number code on the serial number label on the rear panel. An example of the model number format is as follows:

M100AVS5-X.X-ZZZ

where X.X represents F.S. kilovolts and ZZZ represents FS current in mA.

1- 14 IDENTIFICATION

1-15 The ROD-L AC Hipot Testers are identified by a Model Number as described in paragraph 1-13 and a serial number (see figure 2-2). The serial number is a manufacturer identification of the instrument.

1-16 SPECIFICATIONS

Table 1-1 lists the most important electrical, environmental and physical specifications of the Hipot Testers.

Table 1-1 SPECIFICATIONS

Test Voltage and Current	User adjustable up to 5000 VAC RMS, 50/60 Hz, 0-333 mA. **Note:** Voltage and current range combinations are detailed in paragraphs 1-12 and 1-13.
High Voltage Shutdown	Within 2ms after a fault is detected (electronic shutdown circuit)
Automatic Test Cycle	One second to 90 seconds.
Initial Turn-on Period	Requires 2 seconds for safety ground test before H.V is applied.
Safety Ground Continuity	Reject level 0.5 ohm $\pm$ 0.1 ohm; operates whenever ground is connected. (Low current, 1.0 amp applied).
Volt Meter	Accurate to $\pm$3% F.S.
Voltage Monitoring Circuitry	$\pm$1.0% through full range.
Ammeter	Accurate to $\pm$ 3% F.S.
Current Monitoring Circuitry	$\pm$ 1.0% through full range.
Ammeter Resolution	Better than 3% F.S.
Current Circuitry Resolution	Better than 1.0% F.S.
Voltmeter Resolution	Better than 3.0% F.S.
Voltage Circuitry Resolution	Better than 0.1% F.S.
Input Power	110/240 VAC, 50/60 Hz, 500 W max (30W typical); 115/230V switch:
Environmental Operation Conditions	0° to 50° (32° to 122°F).
Physical Color	Mint grey/olive grey
Weight	35 lbs (15.9 kg) Net Shipping: 38lbs (17.2 kg)
Dimensions	16 3/4 x 5$\frac{1}{4}$ x 13$\frac{1}{4}$ inches (43 x 13 x 34 cm)

Safety Features

- Sequenced design of operation.
- Loss of safety ground terminates test cycle.
- No external HV leads.
- Recessed START button.
- Visual and audible alarm at failure.
- High voltage lockout requiring manual reset.

INSTALLATION AND OPERATION

Section II

2-1 GENERAL

2-2 This section contains the recommended procedure for unpacking, inspection, installation, operation storage and reshipment.

2-3 UNPACKING AND INSPECTION

2-4 Any shipping carton that appears damaged should be unpacked with the carrier's agent present. Inspect the instrument for damage (scratches, dents, broken knobs or meters, etc.) If the instrument is damaged or fails to meet specifications (performance tests, Section IV), notify the carrier and ROD-L Electronics immediately. Retain the shipping carton and the padding material for the carrier's inspection.

2-5 INSTALLATION

2-6 The ROD-L AC Hipot Testers are suitable for either bench or rack mounting. To rack mount the instrument, use Rack Mounting Kit ROD-L Option #15, Part No. M100-5001. Order Rack Mounting Kit from factory.

2-7 POWER REQUIREMENTS

2-8 The AC Hipot Tester requires a power source of 115-230 volts AC single phase, 50 to 60 Hz. Insure that the power socket to which the instrument connects has a functioning safety ground.

2-9 POWER CABLE

To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the three-prong connector is the ground pin.

WARNING

This instrument to be used ONLY in three wire grounded outlets. It is recommended that periodic checks of the outlet and the ground cable be made to insure operator safety.

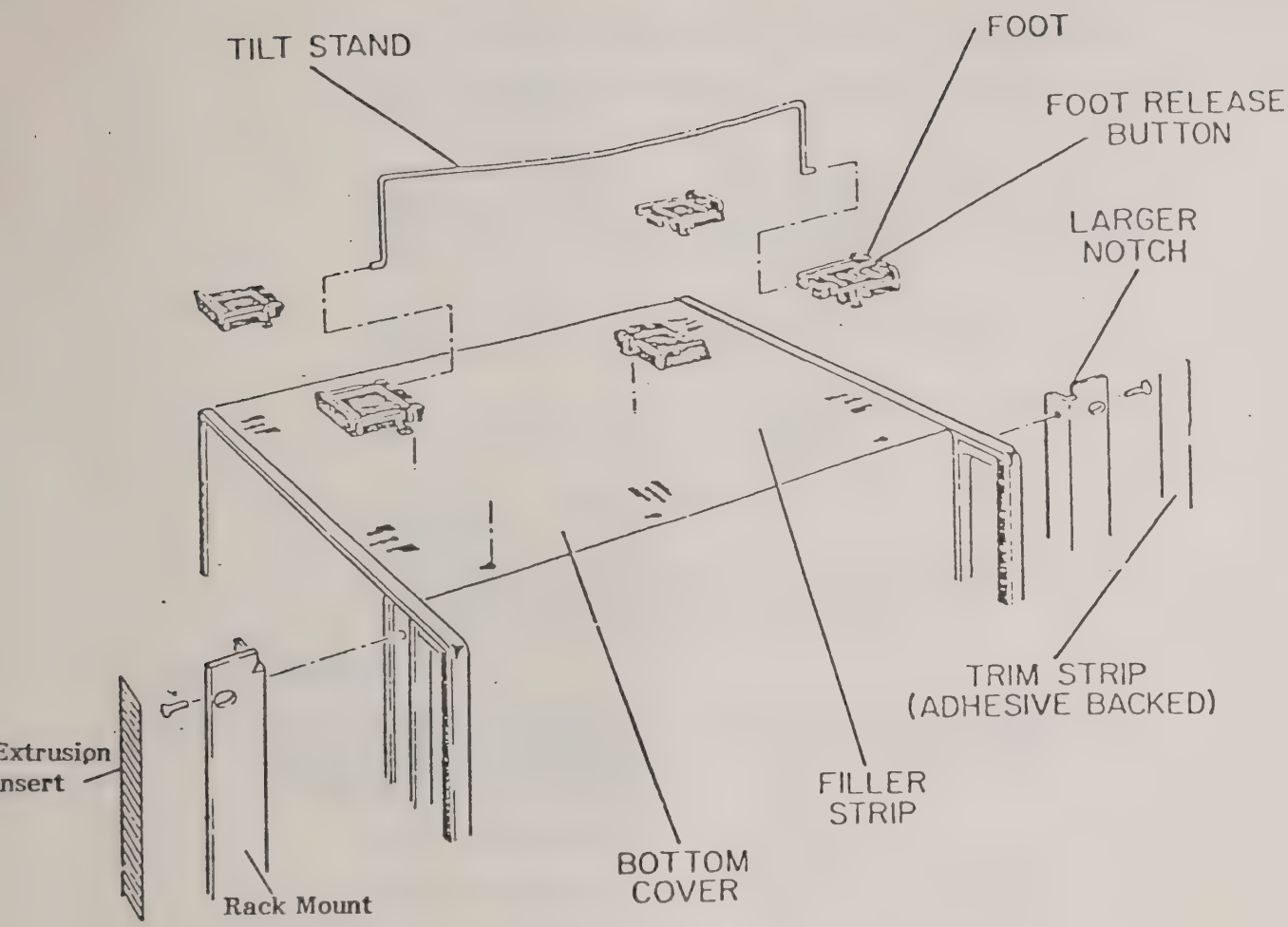


Figure 2-1 Rack Mounting Kit Installation

2-10 INITIAL INSTALLATION AND TURN-ON

2-11 This instrument is shipped ready for 115 VAC operation unless specifically requested by customer to be set at 230 VAC. Spare fuses are provided for 230 VAC operation. Prior to applying power to the instrument, perform the following:

CAUTION

Turn off the AC Hipot Tester and install the proper rated fuses, otherwise damage to the instrument may result.

a. Set the **TOTAL CURRENT** control to full clockwise position.

b. Set the **REAL** or **RESISTIVE CURRENT** control to full clockwise position.

c. Set the rear panel AC LINE 115/230V voltage switch to indicate the number that corresponds to the line voltage being used. The number visible on the slide switch indicates the line voltage for which the primary circuit is connected.

d. With an AC voltmeter, check the primary power line for nominal line voltage conditions.

e. Check to be sure that the proper fuses are installed in accordance with markings on rear panel.

f. Connect the 6-foot power cord between instrument and power source.

g. If this is the initial turn-on of the instrument, perform Operational Check procedure per paragraph 2-28.

2-12 STORAGE

2-13 It is strongly recommended that the equipment be packed as if for reshipment. Environmental conditions during storage and reshipment should be as follows:

a. Maximum temperature 167°F (75°C)

b. Minimum temperature -40°F (-40°C)

2-14 REPACKAGING FOR SHIPMENT

2-15 If possible, use the original shipping container and packing materials, or:

a. Wrap the instrument in heavy paper or plastic before placing it in the shipping container.

b. Use plenty of packing material around the instrument and protect the front panel with cardboard. Protect the instrument with 2 inch rubberized/foam padding placed along all surfaces of instruments, or with a layer of excelsior about 6-inches thick packed firmly against all surfaces of the instrument.

c. Use a strong, well sealed shipping container (350 lb/sq in. bursting test).

d. Mark the container "FRAGILE - DELICATE INSTRUMENT".

2-16 Attach a tag to the instrument, giving the following information:

a. Type of service required

b. Instrument model number.

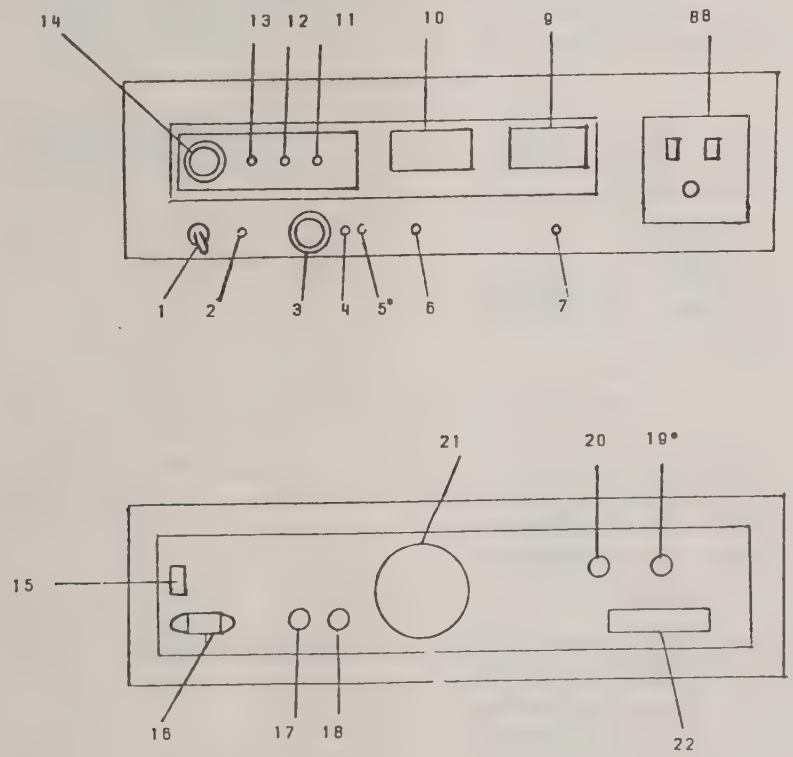
c. Full serial number.

d. Return address.

2-17 In any correspondence, refer to the instrument by model number and full serial number.

2-18 OPERATING CONTROLS

2-19 Figure 2-2 illustrates the front panel and rear panel controls for the AC Hipot Testers. Table 2-1 describes the functions of all the controls and indicators.



* 8V Model only

Figure 2-2 Controls and Indicators

Table 2-1 Controls and Indicators

Fig 2-2 INDEX NO.	CONTROL	FUNCTION
1	LINE POWER ON (S1)	This switch applies or removes power from the instrument.
2	ON lamp	When lit, it indicates power is applied to the instrument.
3	START pushbutton (S5)	When depressed, the test sequence begins if the instrument is grounded properly and not already indicating grounded test failure.
4	RESET pushbutton (S6)	Resets a failure indication when depressed; also terminates a test early.
5	Push for output Current-Real Part pushbutton (S4-BV) (Model BV only)	Expands the current meter scale by ten to indicate the real part of the AC current flow when depressed during a test.
6	TIMING Select Switch A or B (S-7)	Selects preset test times and ramp rates assigned to positions A and B. Standard factory settings are: **Position A:** 200V/sec* 60 sec. **Position B:** 200V/sec* 1 sec * For 5KVAC F.S. Models, the ramp is 500V/sec.
7	CHASSIS GROUND post (BP1)	Connect the chassis of the device under test to this terminal. The lead used should be of low resistance and preferably as short as possible (36" cable supplied).
8	High Voltage Connector (J3)	An instrument to be tested for leakage is to be plugged into this outlet. Only three pronged AC line plugs for three-wire cords are to be inserted (unless adaptor is required).
9	OUTPUT VOLTAGE meter (M1)	Provides a direct reading of the AC test Voltage applied to the instrument under test.

Table 2-1 Controls and Indicators (continued)

Fig 2-2 INDEX NO.	CONTROL	FUNCTION
10	AMMETER	Indicates amount of AC leakage current (in mA) flow during a test.
11	FAIL indicator lamp (13)	Displays a visual warning that DUT failed test.
12	TESTING Indicator lamp (14)	Indicates a test in process.
13	READY Indicator lamp (12)	Indicates proper ground is established between the tested instrument and the Hipot Tester. Instrument will not operate if READY lamp is not on.
14	Audible Warning (SP1)	Emits a warning sound when a test results in failure.
15	AC LINE Voltage Switch (S2)	Slide switch to select either 115 VAC or 230 VAC. The exposed number indicates the line voltage selected.
16	AC LINE Power Power Receptacle (J1)	Connects to power cable supplied with instrument.
17	High Voltage Line fuse (F2)	Provides overcurrent protection for the primary circuit of the high voltage transformer. At 115 VAC use 2A fast blow and at 230 VAC use 1A fast blow fuse (unless otherwise noted).
18	Power Line Supply Fuse (F1)	Provides overload protection for low voltage transformer primary circuitry. Use 1A for 115 VAC and ½A for 230 VAC operation.
19	REAL CURRENT FAILURE SETPOINT Potentiometer (R2); Model BV	Establishes a maximum level for resistive current flow which cannot be exceeded during a test. If this value is exceeded, a failure indication is given.
20	TOTAL CURRENT potentiometer (R5)	Allows the user to specify a maximum value for total AC current flow during a test. If this value is exceeded, a failure indication is given.
21	VARIAC CONTROL	Allows programming of the high voltage output.
22	Identification Label	Contains instrument model and serial number information.

2-23 SAFETY FEATURES

2-24 The safety features built into the ROD-L AC Hipot Testers are as follows:

a. The security CHASSIS GROUND wire must be connected from the AC Hipot Tester to secure low resistance point on the unit under test. This will allow the READY light to turn on and the AC Hipot Tester to operate. This wire parallels the normal ground wire in the power cord. To insure that both grounds are secure, 1 amp rms at 1.5 volt AC is passed through both grounds at all times. If the total path resistance proves greater than $\frac{1}{2}$ ohm, the READY lamp will not light.

b. When the FAIL lamp is activated, the AC high voltage is immediately removed from the AC Hipot Tester front panel test connector within 2msec. The FAIL lamp can be activated if the following conditions occur: Real or Total AC currrent exceeds the present value; the security CHASSIS GROUND wire becomes disconnected while the high voltage is applied; and an arcing occurs. If a failure is indicated, the device did not pass and should be investigated for reason, repaired and retested.

c. To prevent surges, the AC test voltage is turned on slowly using automatic circuitry.

d. The START pushbutton is recessed to prevent accidental triggering.

e. The RESET pushbutton can be used to prematurely stop the test, if desired, and must be used whenever the device under test has failed.

2-26 USER RESPONSIBILITY

2-27 The user is responsible for determining the applicable test voltage and test duration for their product in accordance with certification agency (UL, CSA, VDE, BSI, IEC, etc) requirements. User also determines the normal total leakage current (or the maximum allowed by agency) from a representative sample of products under test conditions. From this the user establishes the maximum total leakage considered acceptable for the device. This then is the TOTAL CURRENT FAILURE SETPOINT for the device. In a similar manner, the REAL CURRENT FAILURE SETPOINT is estabIlished for the ROD-L Model BV.

2-28 OPERATIONAL CHECK FOR AC HIPOT TESTERS

2-29 This is an operator oriented procedure which allows operational check of the ROD-L AC Hipot Tester without test equipment. Operational procedure is as follows:

a. Set LINE POWER switch to OFF.

b. Connect 36" ground cable to the CHASSIS GROUND terminal. Attach the cable clip end to the AC Hipot Tester or the metal portion of the handles (AV models only). For BV models, attach cable clip end to chassis of DUT. Ensure grounded power- cord of DUT is plugged into front panel receptacle of Hipot Tester.

c. Set line POWER switch to ON and white power lamp should glow. After approximately two seconds, the green READY lamp should light.

d. If the READY lamp does not light, insure the ground connection is secure.

e. With READY lamp lit, push the start control and quickly disconnect the ground cable. The red FAIL lamp lights and the audible alarm should be heard. Also the READY lamp is extinguished.

f. Push the RESET control to extinguish the FAIL lamp and audible alarm.

g. Reconnect the ground cable per step "b" and the ready lamp should light.

WARNING

High Voltage is present at test connector when TESTING Lamp is lit and may be extremely harmful to operator if contacted.

h. Push start control: Amber TESTING lamp should light and the OUTPUT VOLTAGE meter should indicate the proper voltage under normal operation.

i. If OUTPUT VOLTAGE meter does not indicate proper voltage adjust the VARIAC CONTROL in the proper position.

2-30 TOTAL CURRENT PROCEDURE

2-31 To set total leakage current trip point for device under test (DUT), proceed as follows:

a. Set test time per applicable agency specification if different from standard factory setting (Refer to Table 2-1, Index #6)

b. Set TOTAL CURRENT control fully clockwise.

c. Connect DUT to AC Hipot Tester and start test. Record TOTAL CURRENT reading for unit.

d. While the high voltage is on, slowly rotate the TOTAL CURRENT pot counter clockwise until the FAIL lamp and audible alarm are activated.

e. Note the position of the slot on the TOTAL CURRENT control. This position corresponds to the total current read on the front panel meter.

f. Calculate the position in which you want to leave the potentiometer using the formula:

$$\text{Setting Desired} = \text{Setting in Step e} \times \frac{\text{max. current acceptable}}{\text{step c measured current}}$$

g. Reset the TOTAL CURRENT FAILURE SETPOINT control to position calculated above. This control can be used to set a current between a meter F.S. reading and approximately 0.05 x F.S.

2-32 REAL CURRENT (BV only PROCEDURE)

2-33 This procedure is identical to that above, except the REAL CURRENT control is adjusted and the "PUSH FOR CURRENT-REAL PART÷10" pushbutton is depressed to read real current.

2-34 TEST TIME ADJUSTMENT PROCEDURE

2-35 The Test Time Adjustment potentiometer is set as outlined in Table 2-1, Index #6, at the factory. The user should set this control in accordance with the regulatory agency's suggested test time for the device under test if different from standard factory setting. To reset the test time duration, proceed as follows:

CAUTION- HV EXPOSURE

a. Turn off power to the AC Hipot Tester.

b. Remove top cover and locate Test Time Adjustment potentiometer "A" on board A21. Set TIMING Switch on Front Panel "A".

c. Re-apply power to the AC Hipot Tester.

d. With top cover removed from Hipot Tester, use a stopwatch to time the duration the TESTING lamp remains ON.

e. By adjusting the Test Time Adjustment trimpot and timing the TESTING lamp duration with the stopwatch, you should be able to set any duration desired between one second and 90 seconds.

f. Set TIMING switch on front panel to "B" and set potentiometer "B: on board A21 per steps (b) thru (e). New instrument is now ready for use.

CAUTION

Do not touch any of the other potentiometers on the PC Boards, otherwise the calibration of the instrument will be ruined.

2-36 AUTOMATIC TEST PROCEDURE

2-37 The following procedure assumes the ROD-L Hipot Tester has been calibrated and adjusted for normal operation. Proceed as follows:

a. Place device under test (DUT) next to Hipot Tester.

b. Plug the power cord of DUT into high voltage connector of Hipot Tester.

c. Connect safety ground cable between DUT and CHASSIS GROUND terminal. If ground is less than 0.5 ohm, the READY lamp will light.

WARNING

High Voltage applied to the device under test. Do not touch the DUT power cord or chassis while the TESTING lamp is lit, or extreme shock may result.

d. Press the START pushbutton. The TESTING lamp should light.

e. Check that the OUTPUT VOLTAGE meter indicates the test voltage. If voltage is high or low adjust rear panel VARIAC CONTROL appropriately to compensate.

f. Restart the test. Observe the total current indication. (Model BV has an additional feature: press the "PUSH FOR REAL CURRENT PART ÷ 10" pushbutton to observe the 'real part' current). The test will automatically abort, giving a failure indication if one of the preset current failure setpoints is exceeded, the chassis ground connection is interrupted or an arcing condition occurs due to dielectric insulation breakdown. The operator should investigate to determine which failure occurred in the event a FAIL indication is given. For this reason the ammeter should be continuously monitored during the test.

g. For a normal test, the TESTING lamp will extinguish after a completion of the preset test time duration. If a test results in a failure condition, the FAIL lamp will light and the audible alarm will sound. The operator must then manually press the RESET pushbutton before a test can be repeated.

NOTE

At least 5 seconds must elapse between TURN-ON and the first Hipot Test and 1 second must elapse between successive Hipot tests or random "FAIL"indications may occur.

THEORY OF OPERATION

Section III

3-1 THEORY OF "DIELECTRIC WITHSTAND TESTING"

3-2 The dielectric withstand test is one of many tests required by many certification agencies (UL, CSA, BSI, VDE, IEC, etc) as "Proof" of an instrument's ability to withstand excess surges on the AC power lines without becoming a hazard to itself or the user. It is well known that lightning, drastic load changes or power line outages can place short duration spikes on the AC power line of many times the nominal line voltage; and devices should be designed with this in mind. Thus, testing laboratories require that each instrument certified by them be tested for dielectric withstand requirements.

A test at 1500 VAC is required of most instruments having a 115/230 volt switch and for sale in both U.S. and Europe. However, instruments designed for some different uses may have other requirements.

The ROD-L AC series tester applies a sine wave at 60 hz or 50 Hz of the required voltage between the two current carrying leads of "device under test" (i.e. the "Hot" and "Neutral" conductors tied together) and the "Ground" conductor of the "device under test". An additional "Safety Ground" connection must be made to insure grounding integrity. The "Device under test" must "withstand" this application of voltage without displaying any indication of deterioration archover, sparking, overheating or other type of failure. Visual inspection of most of these characteristics is precluded in a closed circuit instrument. An ammeter is provided on the AC series instruments for displaying actual leakage current.

It may be thought that if there is no physical connection between the AC power line and the chassis of the instrument under test there can be no current flow. This is not, in general, true. There are always parasitic capacitances and resistances present which allow some current to flow. At 1500 VAC, 60 hz, every 1770 pf of stray capacitance allows 1 mA of current flow. If a power transformer is contained in the circuit interwinding leakage capacitances of from 100 pf to 1000 pf are common.

Furthermore, many instruments require capacitors to be connected between the AC power line and chassis to eliminate any RF energy being transmitted through the line cord. The circuit schematic of the "device under test" should be inspected and leakage current for any capacitors of this type should be computed using this formula:

$$I_C = V_C (2\pi f C)$$

$$= 1500 \times 377 \times C \qquad \begin{matrix}\text{(at 1500 VAC)} \\ \text{(at 60 Hz)}\end{matrix}$$

and these currents considered "normal" for that instrument.

The above formula assumes that the capacitors being tested are "perfect", i.e. linear and have "zero" dissipation. The real world is never so obliging. Ceramic capacitors (these normally used for this purpose) have tolerances of 20% or worse, have very nonlinear I-V responses at high voltages and have dissipation factors at high voltages of 30% or more. Thus, the actual current flow may be 150% or more of the theoretical flow for that capacitor. Actual currents can only be confirmed by testing of a large number of instruments and computing tables of expected and worst case values. Then any current above this "worse case" value can be considered a cause for rejection.

The BV tester measures the "Real Part" of the AC current as well as the total current. Nonlinear operations (sparks, arcovers, etc.) invariably increase the "Real Part" of the current much more than they increase the total current. Thus, these effects can be more easily detected on the BV testers.

Resistive parasitic effects can occur as well. These can be caused by moisture or dust between conductors, rosin or acid flux "bridges" between PC board traces, leaky insulating materials, etc. Considerable power can be concentrated in these leakage paths. Only 1 mA of current at 1500 volts means that some point must dissipate 1.5 watts of power. That much power concentrated in the very small area of flux "bridge" can easily cause a fire hazard.

Real current also flow due to non-ideal filter capacitors. The "Real Current" flow in a capacitor can be computed by multiplying the capacitor dissipation factor by the total current flow, and as has been stated, this can be appreciable and very nonlinear. The published low voltage dissipation factors of capacitors gives only a limited projection of what to expect at high voltages and actual results are invariably high.

3-3 INSTRUMENT FUNCTIONAL DIAGRAM

Functionally, the AC Hipot Tester is divided into three sections: The HV generator, the HV control and the General Control. A remote control option can be added to the total system. (As shown in Fig 3-1).

3-4 **The HV Generator** consists of an AC HV transformer (50/60 Hz) specially designed to provide the high voltage and current needed in Hipot Testing.

3-5 **The HV Control** is the most important part of the system, it contains: The unique solid state **HV Amplitude Control** and the Ramp Up Control **Circuitry.** The **HV Amplitude Control** operates under the principle of generating an adjustable amount of blocking voltage to the input line voltage coming out from the Variac as shown in Fig 3-2

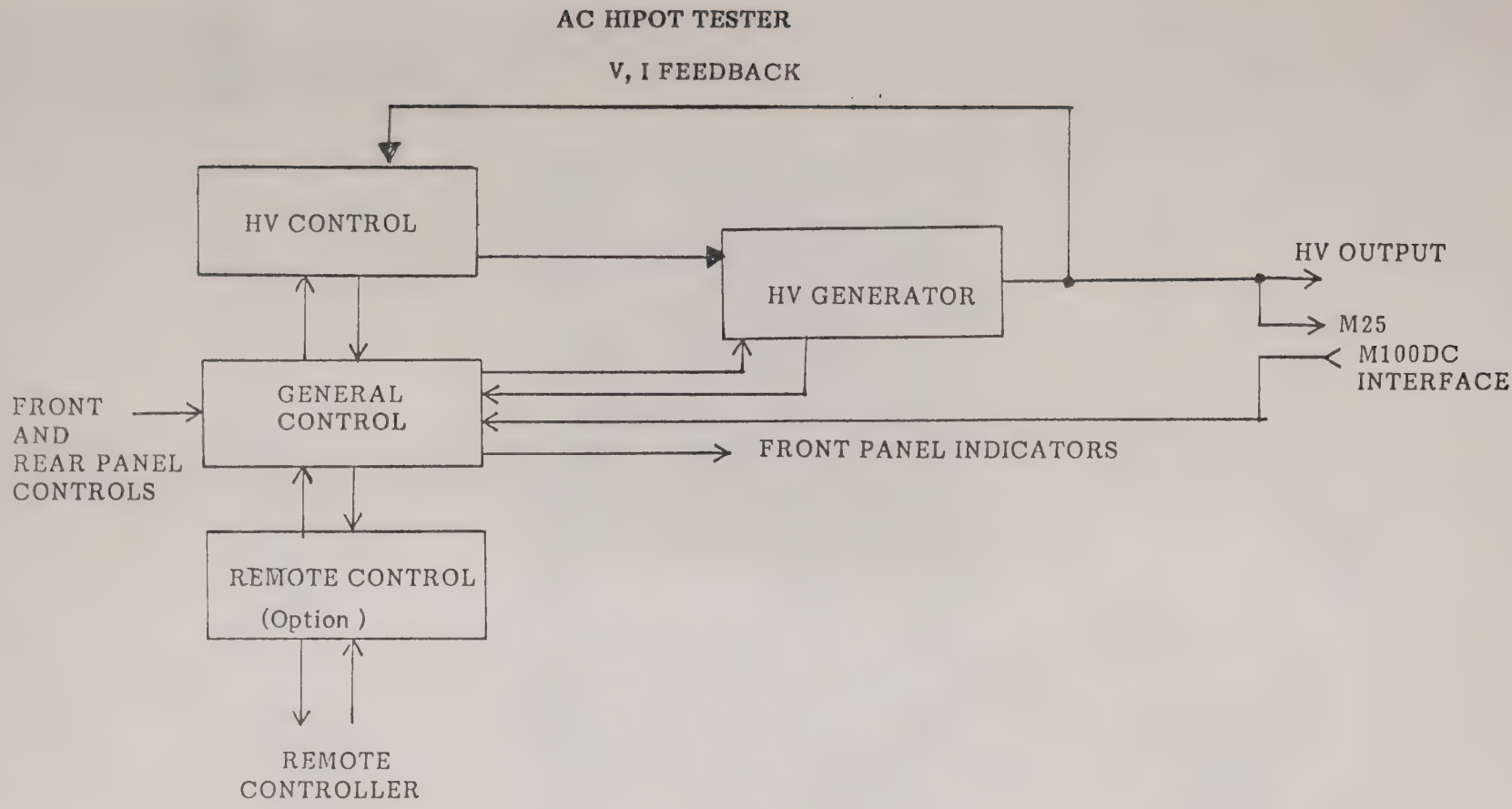


Fig. 3-1 Functional Diagram

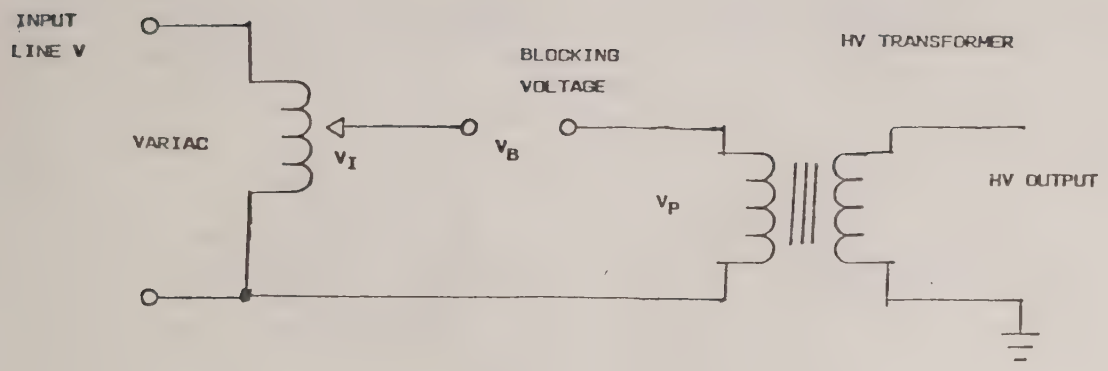


Fig. 3-2 HV Amplitude Control

The HV output is directly proportional to V_P. Where V_P is the voltage V_I given by the variac minus the blocking V_B generated across the HV Amplitude Control. When the blocking voltage V_B equals or exceeds the voltage V_I ,V_P is zero as is the HV output. As V_B decreases V_P begins to be different from zero producing HV in the output of the HV transformer. This unique system has proved to be the most efficient solid state way to control the HV amplitude not only in terms of dissipating power but in terms of practical immunity of the amount of blocking voltage V_B to the nature of the load connected at the HV output, which makes the HV amplitude independent of the load and sinusoidal through all the linear Ramp-up to full voltage.

The **Ramp Up Control** circuitry compares the ramp up reference signal with the voltage feedback from HV output producing a width modulated pulse signal of double frequency of the input line. This signal controls key parameters in the **HV Amplitude Control** causing the HV output to follow the Ramp up reference signal as shown in Fig 3-3.

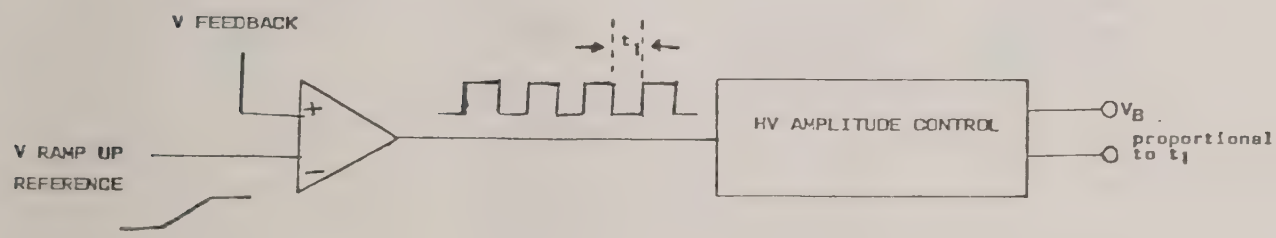


Figure 3-3 Ramp Up Control

3-6 The **General Control** performs the coordination of the different activities and monitoring. As shown in Fig. 3-4

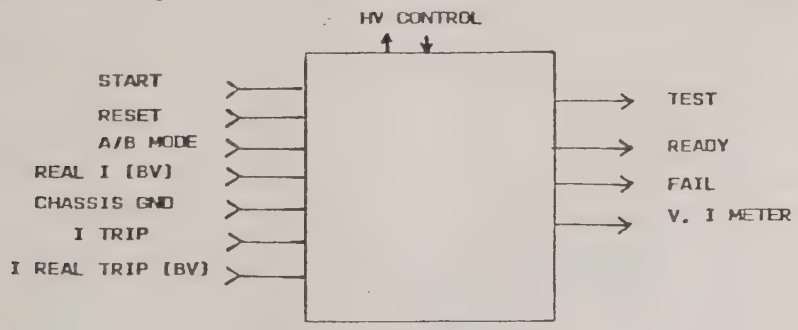


Fig. 3-4 General Control

The General Control can be commanded from the different front and rear panel control shown on the left side of the diagram. It takes care of coordinating the different activities of the HV Control and sensing the status of the operation. It provides continuous monitoring through the front panel lights, buzzer and meter shown on the right side of the diagram.

The **remote** option is an isolated interface for most of the control and monitor signals.

3-7 INSTRUMENT ASSEMBLY DIAGRAM

The instrument is divided in two major subassemblies as shown in Fig 3-5

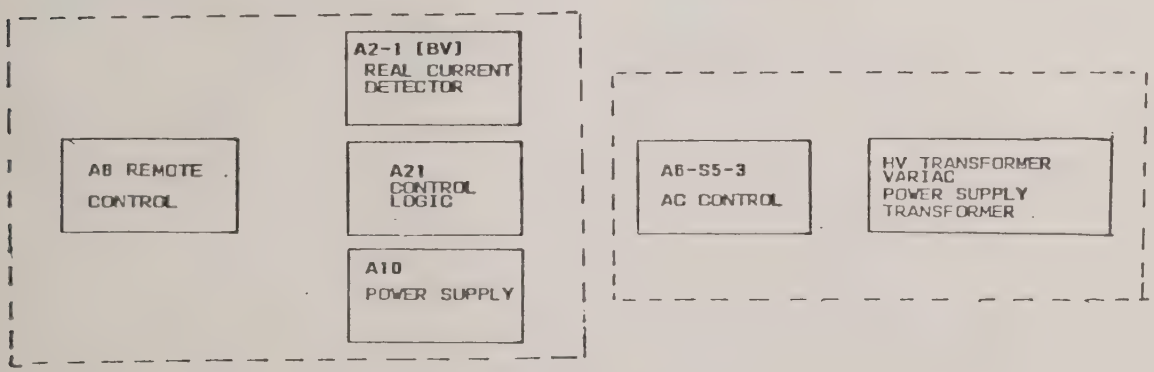


Fig. 3-5 Assembly Diagram

The right side subassemblies is physically separated and contains the A6-S5-3 board and the electrical transformers needed for the operation, practically high voltage circuitry. The left side subassemblies contains the A10, A21 and options A2-1 for BV models and A8 REMOTE (all low voltage circuitry).

A more detailed diagram of the board's functions is shown in FIg. 3-6

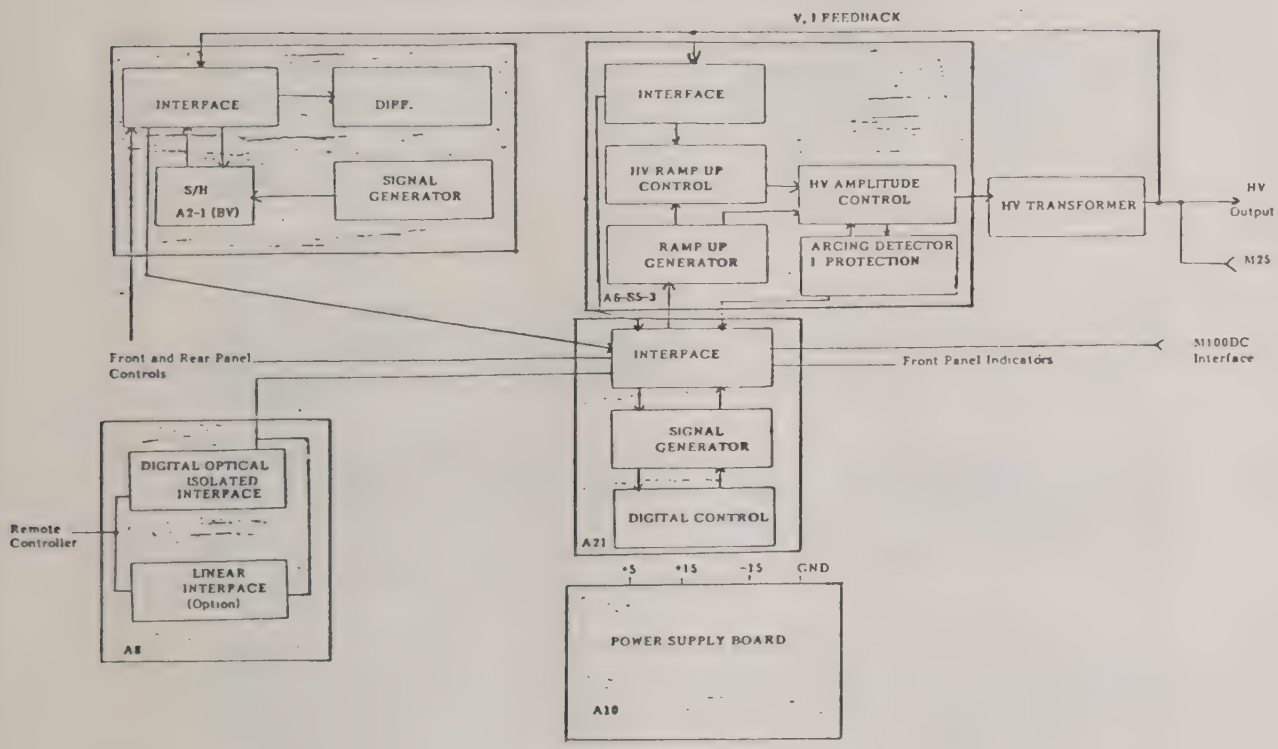


Fig. 3-6 Detail Assembly Diagram

3-8 POWER SUPPLY CIRCUIT (A10)

3-9 Power generated in the A10 assembly board, consists of +15 VDC and -15 VDC regulated for the analog circuits.

The digital electronics requires +5 VDC regulated. As seen in the schematic (dwg. 00418 or Dwg 00419) of the main chassis.

3-10 HIGH VOLTAGE CONTROL/SLOW TURN ON (A6-S5-3)

3-11 This board contains the most important parts of the systems: The HV CONTROL and the RAMP UP CONTROL. Supporting them are the RAMP UP GENERATOR and the VOLTAGE FEEDBACK. The output CURRENT and VOLTAGE monitoring circuits and the PROTECTION AND ARC DETECTION are also included (See Dwg. 00423).

HV CONTROL

This part produces a desired blocking voltage level for the input line. As this level decreases, more input line voltage gets through the primary of the HV transformer producing more high voltage at the output.

The amount of blocking voltage depends on the equivalent resistance seen by the base of **Q6.** The reset of the transistors **Q2, 3, 4, 5, 6, 7, 11, 14** are used to drive the primary of the HV transformer and to share the input line voltage between an upper and lower set of transistors during the voltage transients.

The relay **K1** closes its contacts to force the base of **Q6** to a value close to its initial condition. When **K2** closes its contacts the base of Q6 **MUST** reach the initial condition value before the RAMP UP CONTROL begins to operate. The K2 contacts enables the gate Q1 to allow the input line voltage to go through the board and enables the driving capability of the HV CONTROL.

VOLTAGE FEEDBACK AND MONITORING

The HV output is fedback through a dividing network of HV precision resistors to produce an average current through the voltmeter proportional to the RMS value. In series with this voltmeter is **R1** which delivers a full wave rectified waveform to the differential amplifier in **U5**, this signal is further filtered to monitor the HV, in this case, the peak of the waveform is used instead. The resistor **R4** is in series with the HV output and senses the output current.

RAMP UP GENERATOR

When the signal TP6 gets low a certain time after the input $\overline{\text{TEST}}$ falls (adjustable by the pot R32), the voltage at the input of CR17 becomes negative and no current flows through it. So, only the current flowing through R45 and determined by one of the pots R27, 28, 30 goes through the capacitor C13 charging it. Since the charging current is constant the output of U7 (10) is a linear RAMP UP.

RAMP UP CONTROL

U5 also compares the Ramp Up signal with the output of U5 (10) producing a train of pulses of 120 Hz which is width modulated by the magnitude of the HV feedback for a particular value of the Ramp Up signal. An amount of HV is produced in the output such that a certain width is obtained in the train of pulses which determines the conduction and non-conduction time of U3 and finally the average current sinked in the output of U3. This value of current determines the amount of equivalent resistance at the base of Q6 to produce the amount of HV at equilibrium.

PROTECTION AND ARC DETECTION

Q9, 10, 12, 13 and 15 forms a special configuration which detects small voltages across R16, 18 when the voltage across the output power transformer is large. The voltage across R16 and R18 is proportional to the ourput current, so the condition detected is that of a short at the beginning of a test. The level of voltage across the output power transistors for which we want to sense is adjustable by R26. U1 transmits the condition detected to the A21 control board U2 senses for currents several times higher than the full scale current. This condition comes up during the arcing, and it is transmitted to the A21 also. Q8 limits the output current by limiting the current going to the base of Q6 when a serious overcurrent condition occurs, while the shut down circuitry works.

3-12 REAL CURRENT DETECT CIRCUIT (A21)

3-13 The A21 board (Dwg. 03398-01) receives at pin 5 the voltage generated across the voltage sense resistor on the A6-S5-3 board. The first half of U1 operates as a buffer. The first half of U4 makes the derivative of the signal voltage signal which is proportional to the HV output and the second half of U4 converts this signal to a square wave signal which rises and falls at the peaks of the voltage signal. U5 produces a small pulse of approximately 10μs width coincident with the positive peak of the voltage signal. U3 is a sampler and holder of the current waveform which provides the necessary filtering along with C13.

The second half of U1 is a leading circuit which is adjusted to provide the exact triggering at the positive peak of the voltage signal to compensate for the circuit delays.

The output pin 10 of U2 is the amplified value given by U3, calibrated by R22 for giving RMS current values to the ammeter through R3. The second half of U2 is comparing the actual real current with the real current trip-point to identify overcurrent failures. Severe non-linearities in a DUT can produce a negative reading on the Hipot ammeter.

When a hipot test is not in progress and the real current button is depressed, the ammeter may show a false negative reading. This circuitry is not intended to be activated when a test is not in progress.

3-14 A21 CONTROL BOARD

3-15 TOTAL CURRENT DETECTOR/COMPARATORS

Board A21 in the M100BV (Dwg. 00236-01) receives the voltage across the current sense resistor, rectifies and filters it and sends it to a comparator that triggers when preset limits of total current are exceeded. The A21 board has a ground loop circuit to detect safety ground violation.

Active Rectifier - Filter: U5 (board A21) functions as a precision full wave rectifier of the AC voltage present on current sense resistor during test. U5 overcomes diode non-linearities by placing the rectifying elements CR2 and CR3 in the feedback path. Summing this signal with $\frac{1}{2}$ the input signal provides a full wave rectified output. C6 on A21 board filters the signal with U4. The output is passed through the "Total Current Metal Cal" pot R19 to the ammeter.

Current Comparators: U1 is used as a high gain amplifier with weak negative feedback and acts as a comparator. R22 and R29 provide common mode protection. C7 provides extra filtering.

3-16 SAFETY GROUND DETECT CIRCUIT.

On the A21 board the circuit composed of R24, R25, CR4, CR5 and U8 half wave rectifies the voltage between ground and the "chassis ground" binding post. This voltage is 1.5 VAC if the "chassis ground" post is OPEN. When the "Device under test" completes the circuit through its ground wire to ground, the voltage at the post is proportional to the resistance of the ground wire in the device under test. R26, R27 and C20 on A21 board determine the trip point for the darlington pair, Q3, Q4 on the A21. The resistors are selected such that a 0.5 ohm loop resistance leaves the transistors OFF. Q2 then operates the READY lamp and controls the START button.

3-17 LOGIC CONTROL

This assembly receives all push button inputs and the sense outputs from the fail comparators and the safety ground logic. When the proper conditions are satisfied, a test sequence is permitted. The duration is set by a timing circuit. In the event of an operator reset or fail condition, the test is aborted. If there is a failure, a warning is presented until manually reset by the user. This assembly includes a zero crossing detector, a timer and a set-reset-flip-flop with associated logic.

Input Control Lines: Four external control lines for the A21 board are; GND TEST, OVERLOAD, START and RESET. The lines are NEGATIVE TRUE. The OVERLOAD condition occurs when either of the comparators are exceeded. The GND test input indicates a good ground loop and normally is approximately 0.5 volts. Should the loop be opened during a test, a failure is indicated. The start of a test is accomplished by pushing the START button which pulses the START line to "0" (but only if the GND TEST line is also "0" since the other side of the START button is connected to it). See the main chassis wiring diagrams for the relevant connections. If the RESET button is pushed, the RESET Line goes down and either turns off the TESTING lamp or turns off the ALARM lamp and buzzer. OVERLOAD goes to "0" if the A6 board senses an overcurrent or arcing condition in the "Slow Turn On" circuits or the comparator (total or real) detects an overcurrent condition. A failure indication is given when this occurs.

Timer and Enable Circuits: To trigger a timing period at U2 on the A21 a start pulse must occur and no failure can be present. The AC Hipot Tester also requires a zero crossing on the 60 Hz AC line. U3 detects this and passes it to U2, R2, R3 and C2 on A21 determines test time. Parts of U6 drive the reset input of the timer if a test abort is required.

Fail Flip-Flop: U7 on A2 are cross coupled to form the FAIL flip-flop. The flip-flop shows a failure condition only during a test cycle attempt gated by U3 and only when either the GND TEST or OVERLOAD Lines have been pulsed. Only the RESET button can clear a failure indication on the flip-flop.

MAINTENANCE AND SERVICE

Section IV

4-1 INTRODUCTION

4-2 This section provides maintenance and service for the AC series Hipot Testers. Included are: tables of recommended test equipment, calibration procedures, troubleshooting procedures, plus repair and adjustment data.

4-3 CALIBRATION

4-4 Nine major calibration points are required for the AC series Hipot Testers. They are:

1. Meter Mechanical Zero.
2. "Total Ammeter" Cal.
3. Test Time Cal.
4. "Real Current" Ammeter Cal.*
5. Voltmeter Cal.
6. Fail Pots Cal.
7. Safety Ground Ohms Cal.
8. Ramp Rate Calibration.

Table No. 1

TYPE	MFR	USE
AC/DC Digital Ammeter Voltmeter (floating input)	Data Tech Model 31 or equivalent.	General Purpose and Calibration of voltmeter and ammeter.
AC Variac	General Radio W8MT3VM or equivalent	AC Line voltage set-up.
120-240 VAC Line Step Up Transformer		220/240 tests
Oscilloscope	HP 175 or equivalent	General Purpose
High Voltage Probe	Simpson #0161 cal test	Voltage Measurements (alternate = Ross Engr. #VMP-15-C.1)
Standard Resistor Box 0.6 ohm and 0.4 ohm 1%	General Radio 510-A or equivalent	Safety Gnd Ohms Check
High Voltage Loads	See Table No. 2	Calibration of ammeters.

* BV Model only.

4-5 SET UP

4-6 The equipment should be set up to ensure testing at 115 VAC plus or minus 1% (low line switch = "Normal") unless otherwise noted. Foreign users may want to re-calibrate on their standard voltages and frequencies. If line frequency is different from 60hz, remember that required capacitor values will change.

4-7 METER MECHANICAL ZERO

4-8 With the Hipot Tester turned OFF, note the positions of the voltage and ammeter pointers on the front panel. They should read zero plus or minus one minor division. If they do not, adjust the zero screw.

4-9 TOTAL CURRENT AMMETER CALIBRATION

4-10 Turn the Hipot Tester on and note that the total current ammeter position is at zero (plus or minus one minor division). Connect "Safety Gnd" wire to the Hipot Tester chassis in AV models and to the HV return of the front panel block in BV models (failure to do this in BV models will produce an erronous ammeter detection) so that the "READY" lamp lights. The meter should still be zero. If not, troubleshoot the "Full Wave Total Current Detect" circuit. Insure that no load is placed in the High Voltage Output Socket.

Push the "START" button:

WARNING

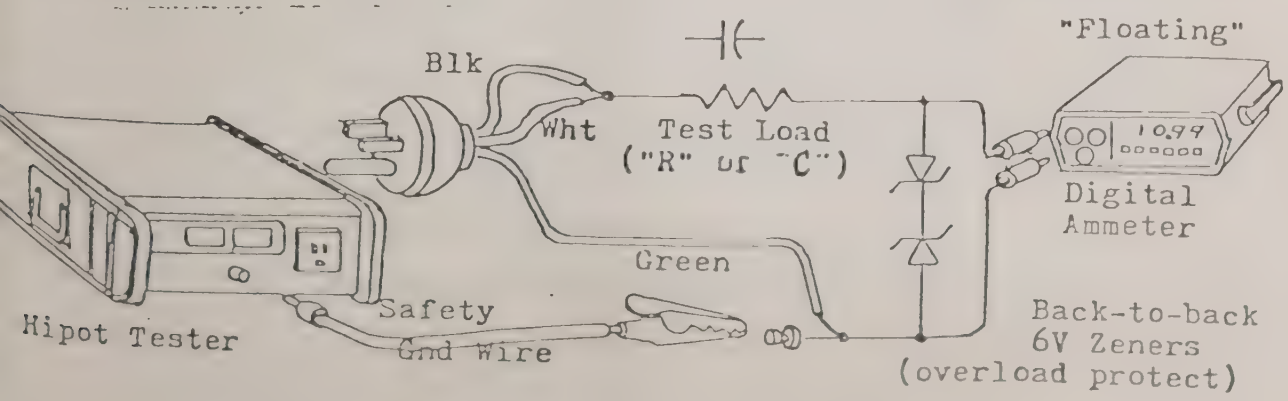
HIGH VOLTAGE NOW APPEARS ON OUTPUT SOCKET

Note the meter reading. It should be zero (plus or minus one division).

Push the RESET button. Insert the Digital Ammeter in series with a 0.95% of full scale HV load resistor (AV Only) or HV load capacitor (AV and BV) per the schematic shown on the next page. Select the value of this load from Table No. 2

Table No. 2

INSTRUMENT	REQUIRED LOAD
M100AV-15-10	160K ohm 3%, 3kV, 20 watt resistor or 0.016μF, 2kVAC capacitor
M100AV-15-50 (was opt 001)	28k ohm 3%, 3kV, 100 watt resistor or 0.08μF, 2kVAC capacitor
M100BV-15-10	0.016μF, 2kVAC capacitor and 1.5 megohm 3%, 3 watt resistor 3kV operating voltage, non-inductive
M100BV-15-50	0.080μF, 2kVAC capacitor and 300k ohm, 3% 3kV, non inductive 10 watt resistor
Other M100AV and M500AV Units	Calculate Resistor Value from this formula: $R = \frac{\text{Hipot Voltage}}{0.95 \times \text{Full Scale Current}}$ 3% Voltage Tolerance > Operating voltage $C = \frac{0.95 \times \text{Full Scale Current (total I meter cal)}}{2\pi f \times \text{Hipot Voltage}}$
All BV Models	$R = \frac{\text{Hipot Voltage}}{0.095 \times \text{Full Scale Current (real meter)}}$ 3% voltage tolerance > Operating voltage



WARNING

Ammeter must be inserted on low voltage side of resistor or capacitor or the ammeter's breakdown voltage to ground may be exceeded. Resistor or capacitor should be tested first to insure that it can withstand rated voltage.

Set ammeter to 100mA full scale. Push START button. Ammeter's current reading should agree with the reading on the Total Leakage Current ammeter within 3% plus or minus of full scale (e.g. for 10 mA F.S. ammeter the two readings should be within 0.30mA of each other).

If they do not, adjust the "Total Current Ammeter Cal" pot - R19 on the A21 board, until it agrees with the Digital Ammeter reading within 1%. See Dwg. 00236-01 for pot positions.

Push "RESET" to end test.

4-11 TEST TIME CALIBRATION

4-12 Set a specific test time per instructions of paragraph 2-35. To check test time limits, turn "Test Time" pot to minimum and maximum. Minimum should be 1 second and maximum greater than 90 seconds. If not, troubleshoot timer or call **ROD-L** Applications Engineer for assistance.

4-13 A2-1 - REAL CURRENT BOARD CALIBRATION

4-14 OFFSET ADJUSTMENT

1. Turn R20 fully counter clockwise.
2. Short pin 5 of the edge connector or pin 2 of U1 to ground.
3. Adjust **R18** to read 0V **at pin 20 of U1** (20mV scale).
4. Adjust **R19** to read 0V **at pin 10 of U1** (20mV scale).
5. Adjust **R17** to read 0V **at pin 12 of U4** (20mV scale).
6. Adjust **R15** to read 0V **at pin 6 of U2** (20mV scale).
7. Adjust **R16** to notice change from about 0V to 15V **at pin 10 of U4.** Hold **R16** exactly where change is done.
8. Turn R22 fully clockwise.
9. Short **Pin 6 of U2** to ground (right side of C13 is a good place).

OFFSET ADJUSTMENT (cont'd)

10. Adjust R23 to read 0V at pin 10 of U2 (20mV scale).

11. Short (tie) pin 1 and 2 of U2.

12. Adjust R24 to produce the change from 15V to about -2V at pin 12 of U2 (5V scale). Hold R24 exactly where the falling begins.

NOTE

Be sure to check the zero everytime the reference scale is changed on the oscilloscope, and through the procedure. After a 20mV scale is used, a 5mV scale is advised.

4-15 TRIGGER AND METER CALIBRATION

1. Connect a resistor with a value of about $\left\{10 \times \frac{\text{High Voltage}}{\text{Full Scale current}}\right\}$ or 200K ±3% ohm, 5KV when no other is available to the output with an external ammeter in series in the low side.

2. Push the START button to generate HV. Push the REAL button and turn R20 slowly clockwise until the ammeter deflects in the positive direction. Continue slowly turning R20 just until the ammeter sharply slows down its relatively fast ascending trip. Slowly turn up the variac if necessary to get a reading on the ammeter equal to about 3/4 of full scale when the REAL button is pushed.

3. Adjust R22 to read the same current on the Front Panel Meter on the external ammeter. Push the RESET button.

4. Connect a capacitor (typically 0.016μF 5kV) to the output. Push START button and check that the reading on the ammeter is positive while adjusting the VARIAC from about 15% to 85% of full position. Otherwise repeat steps 1, 2 and 3. The REAL CURRENT reading here is adjusted to the expected value of REAL CURRENT for that calibrating capacitor at the operating voltage.

NOTE

Distortion may produce a false negative reading on the ammeter when the VARIAC is outside the range described in #4 above.

4-16 VOLTMETER CALIBRATION

4-17 Disconnect all loads from the Hipot Tester. Connect the Simpson probe (connected as a 1000 to one voltage divider by shunting output with a 50k ohm resistor, trim value to compensate for DVM input impedance, system accuracy to be 1% better) to the DVM used. Connect the ground lead of the probe and the SAFETY GND wire from the Hipot Tester to the Hipot Tester frame.

Push "START" button.

WARNING

HIGH VOLTAGES APPEAR ON OUTPUT PANEL BLOCK

The voltmeter should rise slowly from zero after an initial delay. Note the voltage reading. Insert the probe into the OUTPUT SOCKET and read the voltage from the Digital Voltmeter. The two should agree within plus or minus 3% of full scale (or 90 volts). If they do not, change the value of R3 on the A6-S5-3 board until they do.

4-18 FAIL POTS CALIBRATION

4-19 Turn all Failure Setpoint Pots fully clockwise. Insert the Calibration Load listed in Table No. 2 to pull nearly Full Scale Current into the Hipot Tester Output Socket. **NOTE:** Digital ammeter shown on Page 4-3 is not needed in this test. However, the dual banana jacks should be shorted together.

Push "START" button.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST LOAD

While the high voltage is ON, slowly turn the TOTAL CURRENT FAILURE SETPOINT POT counter-clockwise until the FAIL lamp comes ON. Push RESET. Note the position of the slot on the potentiometer. It should be near ten (10) on the scale. If it is less that eight (8), troubleshoot the A21 board or call ROD-L Application Engineer for assistance.

To check the REAL CURRENT FAILURE SETPOINT pot, the resistor load used in paragraph 4-15 is required (BV only). The Digital Ammeter is not necessary for this test. If it is deleted, short the dual banana plug. Reset all SETPOINT POTS fully clockwise. Set up the load and plug into Hipot Tester.

Push "START" button.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST LOAD

While the high voltage is ON, slowly turn the REAL CURRENT FAILURE SETPOINT POT counter-clockwise until the FAIL lamp comes on. Push RESET. Note the position of the slot on the potentiometer. If it is less than six (6), troubleshoot the A21 board or call ROD-L Applications Engineer.

Repeat the test but turn the TOTAL CURRENT FAILURE SETPOINT POT until the FFAIL lamp comes on. It should be near one (1) on the scale. AV users may also want to do this by constructing the appropriate load.

4-20 SAFETY GROUND OHMS CALIBRATION

4-21 Disconnect all loads from the Hipot Tester. Connect a 0.5 ohm resistor between the SAFETY GND WIRE (connected to the CHASSIS GND terminal on the front panel) and the Green Lead of a 115 VAC Line Cord. Cut off the black and white leads. Insure that the resistance of the Green Lead is either negligible or adjust the series resistor accordingly. Make sure that the contact resistance of the Safety Ground Wire is also negligible.

Insert the Line Cord Plug on the HV output socket and the SAFETY GND WIRE to the CHASSIS GND CONNECTOR on the front panel. Turn on the Hipot Tester. The READY lamp should come ON. Push the START button.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST CIRCUIT

The High Voltage should come up normally and no FAIL condition should occur. Push the RESET button.

Replace the 0.5 ohm resistor with a 0.6 ohm resistor. Insert this test circuit into the OUTPUT SOCKET and connect SAFETY GROUND as above. The READY lamp should NOT come on. Push RESET if necessary. The limits on the SAFETY GROUND TEST circuit have been verified. If the limits are not correct, troubleshoot the SAFETY GROUND DETECT circuit or call ROD-L applications engineer.

Finally, disconnect load to Hipot Tester. Connect SAFETY GROUND wire to the frame of the Hipot Tester in the AV model. The READY lamp should come ON. In the BV model the SAFETY GROUND wire coming from the CHASSIS GROUND CONNECTOR cannot be connected to chassis, but rather to the HV return lead.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST CIRCUIT

While the high voltage is on, disconnect the SAFETY GROUND wire. The FAIL lamp should immediately come ON and the high voltage should drop to zero. Push RESET. The READY lamp should NOT light until the SAFETY GROUND wire is again connected to the Hipot Tester.

4-22 RAMP RATE CALIBRATION

4-23 Proper operation of the Ramp Up Control on the A6-S5-3 board should be verified by watching the OUTPUT VOLTAGE METER. Check the delay time (i.e. the time between pushing the START button and the beginning of the rising voltage) and the rise time (i.e. the time between the minimum point and the 100% point of the rising voltage) of the output voltage waveform. Delay time should be between 0.5 and 1.5 seconds. Rise time should be dependent of the Ramp Rate adjustment. No spurious oscillations should be seen. At the end of the turn-on-period, the voltage waveform should be sinuosoidal except for very small amounts of crossover distortion (assuming a low distortion AC power line).

Under full load conditions (use test load from Table No. 2) the output voltage should drop less than 8%. If not, troubleshoot A6-S5-3 board. The waveform should still look essentially sinuosoidal (with actually less distortion than the one received at the input line).

4-24 INITIAL CALIBRATION OF A6-S5-3

Without Running a TEST cycle, adjust the following:

1. Short R1 and adjust R33 to read zero at TP5 (use 20mV scale).

2. Adjust R29 to read approximately negative 100mV at TP7.

3. Turn R35 fully clockwise and R27 fully counter-clockwise. Select mode A on the front panel and adjust TEST TIME for approx. 30 sec.

5. Adjust R32 to get a pulse of about 0.5 seconds at pin 5 of U4 when the START switch is pushed. This may require pushing the START and RESET button several times.

5. Adjust R35 counter-clockwise until a high voltage reading is obtained 0.5 seconds after the START button is pushed. Now adjust R35 clockwise until the voltage reading is about 30V. (approximately 0.5 seconds after the START button is pushed).

6. Adjust R27 clockwise until the rate of rise is as quick as desired.

4-25 RAMP RATE CALIBRATION

Fig 4-2 shows the relation between the different parameters of control.

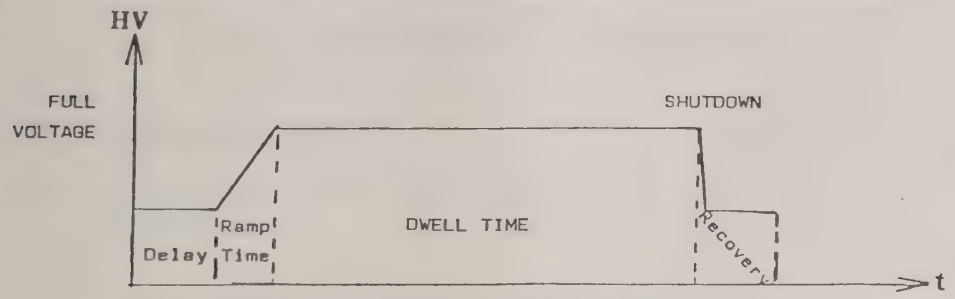


Fig. 4-2 Test Cycle Parameter

The delay time is given by approximately

DELAY = 0.5 + K (RAMP RATE ÷ Full Scale Voltage Sec)

The Ramp Rate is a controllable parameter adjusted by R27 and R28 for Mode A and B respectively. For each instrument the Ramp Rate varies from about FULL SCALE VOLTAGE/Sec to FULL SCALE VOLTAGE ÷ 30/sec. For example, for a 5kV unit the Ramp Rate is adjustable from 5000 V/sec to 166/V sec. K is an instrument constant and varies from about 30 msec to 40 msec. So the expected delay time is about from 0.54 sec to 1.54 sec.

The RAMP TIME depends on the selected RAMP RATE and the FULL VOLTAGE selected.

$$\text{RAMP TIME} = \frac{\text{Full Voltage}}{\text{RAMP RATE}}$$

If the same RAMP TIME is to maintained when the FULL VOLTAGE is changed with the VARAIC CONTROL, the RAMP RATE has to be readjusted.

Test time is the total DELAY plus RAMP plus DWELL time. The recovery time is about 0.5 sec. So, for a 5kV unit with 5000 V/sec Ramp Rate, 5kV full voltage, 1 sec dwell time, the TEST TIME selected has to be 0.54 sec + 1 sec + 1 sec = 2.54 sec and the total test cycle time is 2.54 + 0.5 sec (recovery time) = 3.04 sec.

4-26 For readjusting a RAMP RATE, the following procedure is suggested

1. Select the correspondent mode A or B.

2. Select a large TEST TIME accordingly to RAMP TIME desired adjusting pots A or B in the A21 board and running the test.

3. Push the RESET button and adjust the pot R27 or R28 for RAMP RATE A or B. Clockwise increases the RAMP RATE.

4. Push START button and check the RAMP TIME. Repeat Step #4 if necessary.

5. Adjust the TEST TIME back to desired position.

4-27 TROUBLESHOOTING

4-28 Equipment Require The required equipment is the same as that listed in Table No. 1.

4-29 TROUBLESHOOTING TREE PROBLEM LIST

4-30 The following is a list of problems and potential causes.

A. **No AC Power.**

1. Check fuses F1 and F2
2. Check for bad AC Power Lamp (II), ON-OFF Switch (S1), line filter (1.1 - L2).
3. Measure for line voltage between A6-S5-3, TP2 and TP3

B. **Instrument blows fuses.**

1. Is F1 only blowing? Check for shorted M0V1 or M0V2. Check for shorted T1. Troubleshoot A10 board.
2. Does F2 or F3 only blow? If so, check for shorted output power transistors. Check for internal short on T2

C. **High voltage meter does not turn on slowly.**

1. Check for shorted output transistors. Check for leaky Q14 on A6-S5-3 board.

D. **Ready lamp does not work.**

1. Check for burned out bulb.
2. Check for bad connection at BP1 or bad 1 ohm 3W resistor.
3. Troubleshoot safety ground ohms detect circuit on A21.

E. **No High Voltage**

1. Check for bad fuses F2 and F3.
2. Check for bad START switch
3. Check wiring harness for frayed wiring.
4. Troubleshoot A6-S5-3 board digital logic.

F. Failure indicators do not work or work erratically.

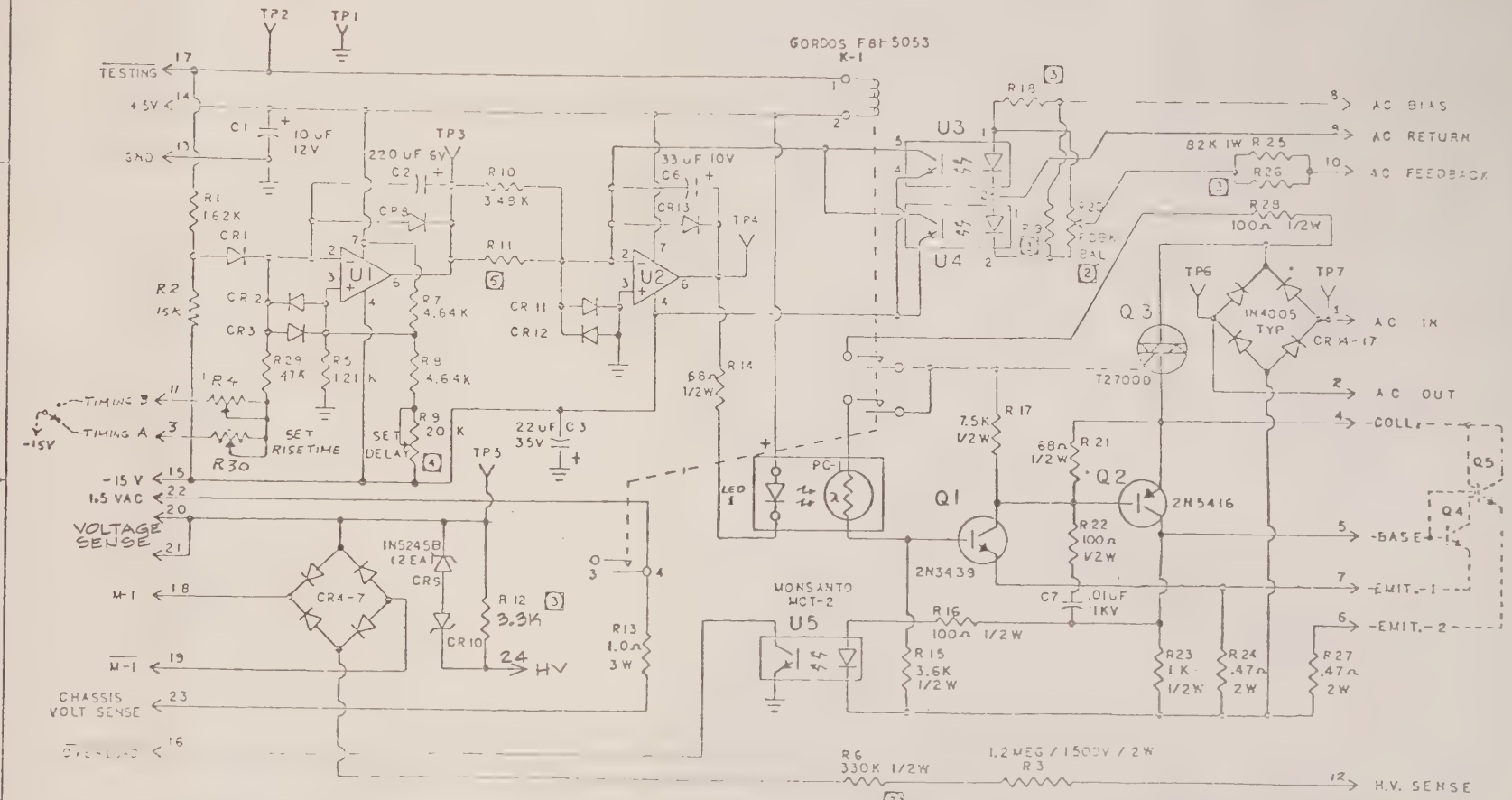
1. Check to see if the leakage current ammeter works.
2. Check signals given by U1 and U2 on A6-S5-3.
3. Determine which of four possible failure modes is being detected. That is, safety ground fault, total current overload, or T2 primary current greater thatn 1.2 amp (overload). Troubleshoot appropriate functional block.
4. Check initial condition voltage at the base of Q6 (A6-S5-3).

G. Excessive power disspation on A6-S5-3

1. Check Q2, 3, 11, 14 for shorts, low beta, etc.
2. Check T2 for internal shorts, corona, etc.
3. Measure voltage between TP2 and TP3 on A6 board with high voltage OFF. This voltage should equal line voltage. With high voltage ON, this voltage should be less than 15 VAC-RMS fully loaded after the Ramp Up. If not, check R35, troubleshoot A6-S5-3.

H. Arcing shutdown does not work.

1. Connect oscilloscope to A21 pin 7 which is optoisolator output. Short Hipot Tester output. Adjsut trigger for a single sweep as optoisolator switches from +5V to 0V and back.
2. Push START. The FAIL lamp should go on after an approximate delay of 1 sec when the HV comes up. The oscilloscope should show a 0.2 to one millisecond negative pulse from the optoisolator thus verifying operation.
3. If no pulse appears or pulse does not fall below one volt, repair optoisolator or associated circuitry.
4. If it appears, check with the factory for increased sensitivity for low level energy arcing.



[5] SELECT FOR 3.0V ± .5V AT TP3 WHEN OUTPUT = 95% OF MAX.

[4] SET FOR ≈ 3 SEC DELAY BEFORE START OF RISETIME (30 SEC RISE)

[3] FACTORY SELECTED PART.

[2] ADJ FOR SYMMETRIC AC OUTPUT DURING RISETIME

1. RESISTORS IN K-OHMS, CAPACITORS IN MICROFARADS, DIODES = IN914

NOTES: UNLESS OTHERWISE SPECIFIED

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADDED R30, CHG DWG # FROM 00209/-5	5/12/71	J Taylor

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN E Taylor	4/29/71
CHECKED	

NEXT ASSY	USED ON
00238-02	M100AY-S5

APPLICATION

ROPAC ELECTRONICS, INC.

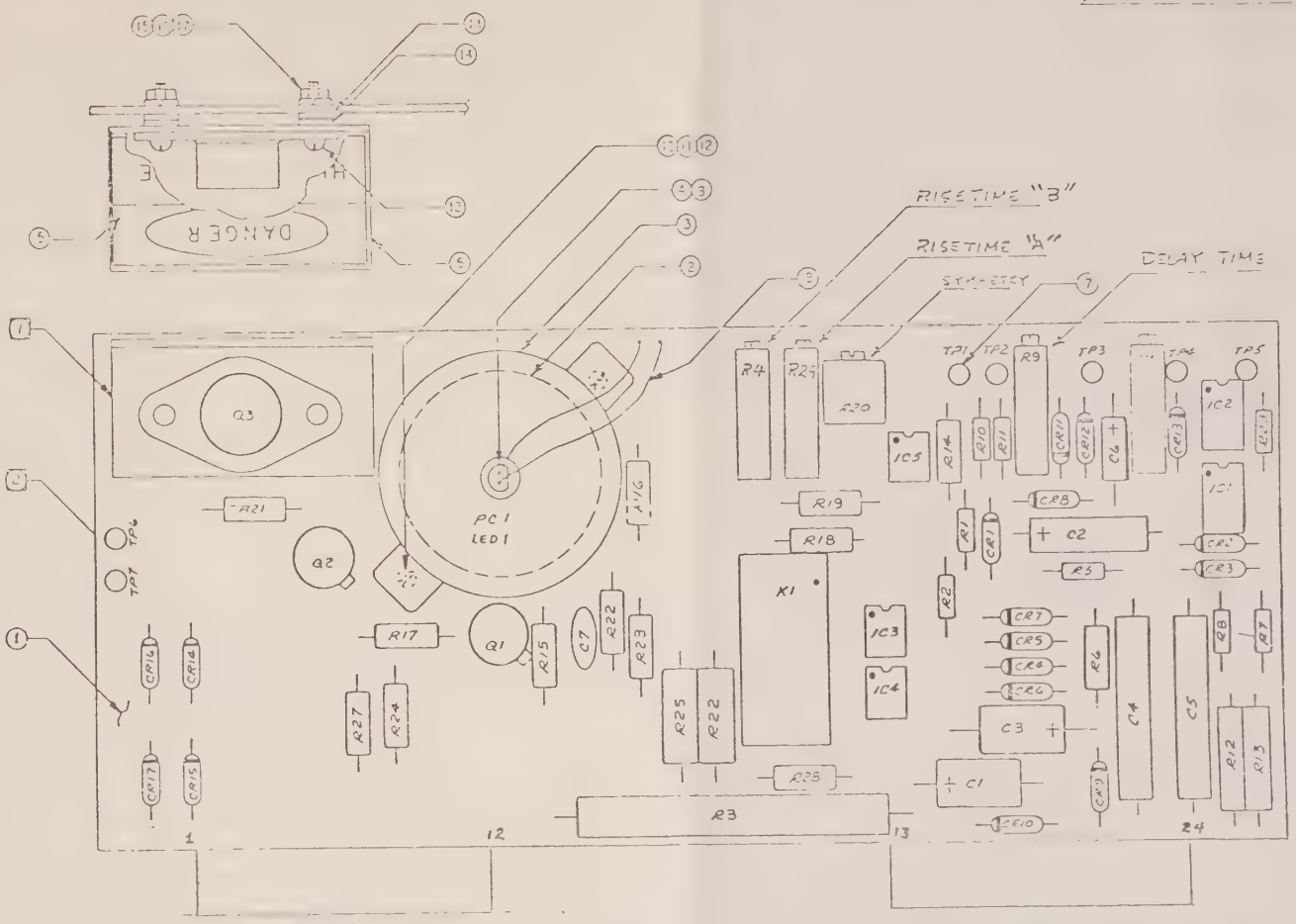
A6-S5
A.C. CONTROL BOARD
LONG RISETIME

SIZE	CODE IDENT NO	DRAWING NO.	REV.
C		00239-01	A

SCALE

SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
		ADDED R29/RELOCATED Z7/DWG NR 210	5/29/73	[illegible]



QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
			PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

CONTRACT NO.

APPROVALS	DATE
DRAWN JGS Design	4/29/77
CHECKED	

MATERIAL

FINISH

DO NOT SCALE DRAWING

ROD ELECTRONICS, INC

ASSEMBLY DRAWING, P.C.B.
AC CONTROL BOARD (AG-S5)

SIZE	CODE IDENT NO	DRAWING NO.	REV
C		00238-02	A

SCALE 2:1 SHEET 1 OF 1

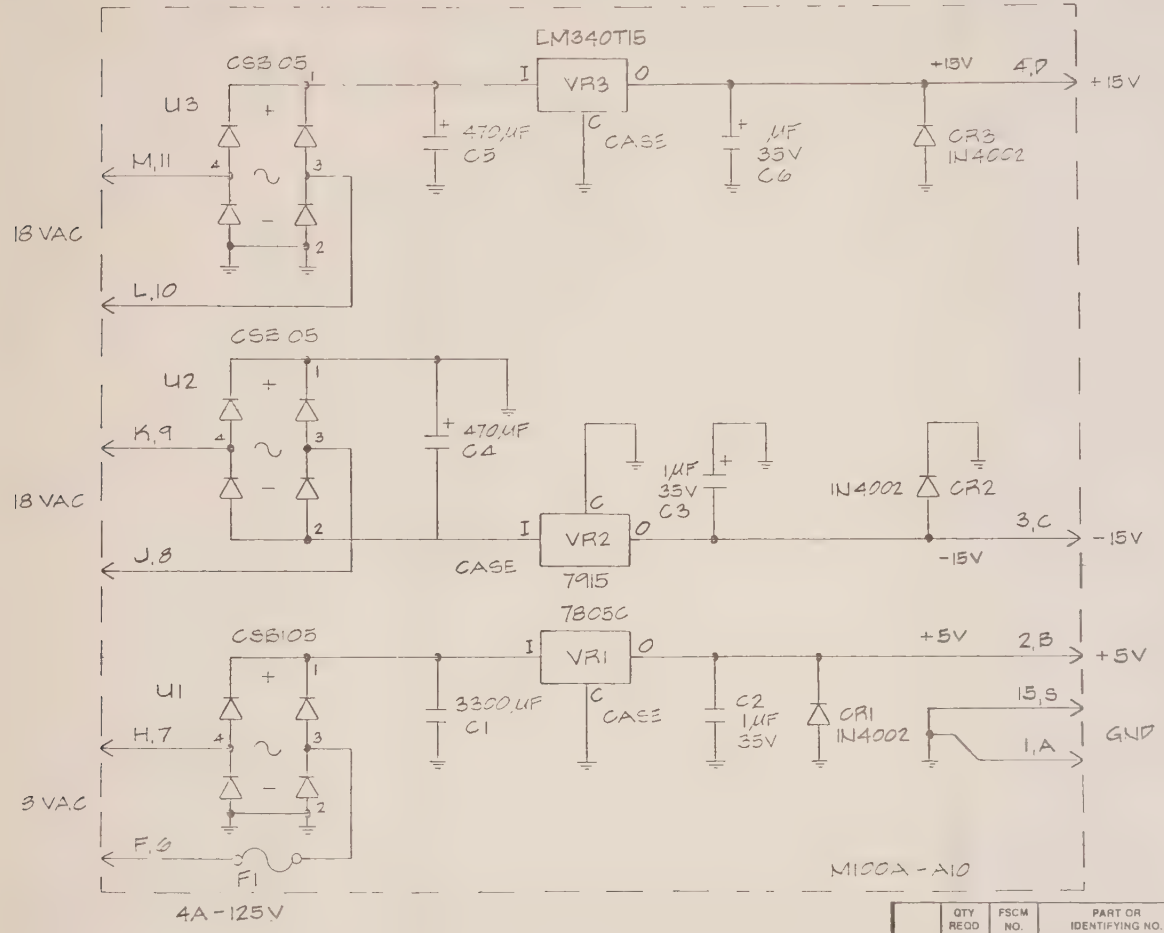
00237-03	M100A-S5
NEXT ASSY	USED ON
APPLICATION	

[2] [illegible]
[1] APPLY DOW CORNING COMPOUND #340 PER MFGS SPECS.

NOTES: UNLESS OTHERWISE SPECIFIED.

DWG. NO.	SH	REV.

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	ADDED TRACE FOR (-) OF C4, CHANGED PARTS CALL-OUT AND PARTS LIST.	6-25-84	BILL



NOTES:

1. ALL DIODES IN4002, U1, U2 AND U3 ARE MECHANICALLY SECURED TO COPPER GROUND PLANE AREA FOR HEAT SINK.
2. F-1 PROVIDES SHORT CIRCUIT PROTECTION IF REGULATOR OUTPUT IS SHORTED AND VR1 FAILS.

THIS DRAWING REPLACES DRAWING # 00100-01

	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO

APPROVALS	DATE
DRAWN JUN	3-8-84
CHECKED	
DESIGNED	
ISSUED	

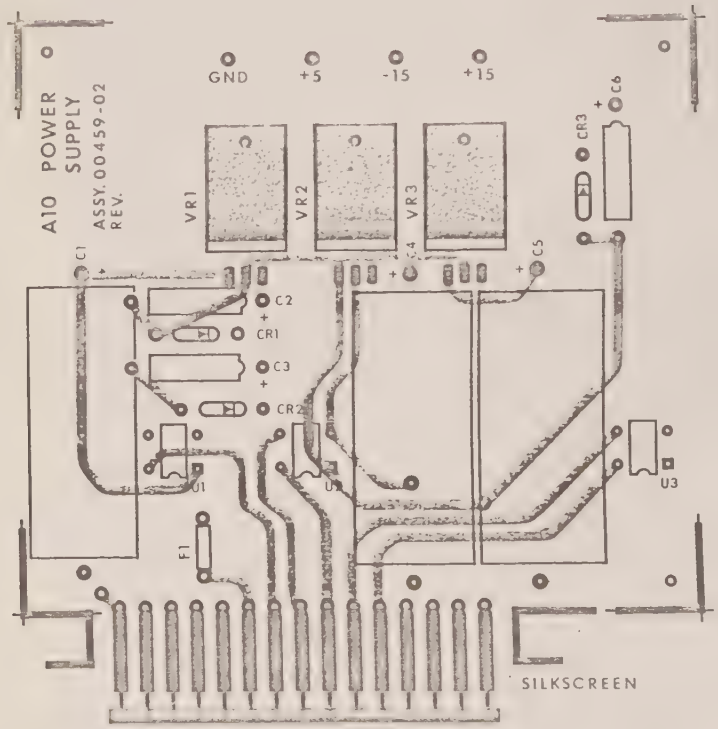
ELECTRONICS, INC. 1098 HAMILTON COURT • MENLO PARK, CALIFORNIA 94025 • (415) 322-0711

POWER SUPPLY
A10

SIZE	FSCM NO.	DWG. NO.	REV.
B		00459-01	A

SCALE —— SHEET

SHOP GRAPHICS/ACCUPRESS



PADMASTER

OUTSTANDING ECNs	

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
ANGLES ± 1°
SURFACE FINISH ✓

DO NOT SCALE DRAWING

DRAWN BY: LE DATE: 6/84

CHECKED

ENGINEER

PROJECT ENGINEER

MATERIAL

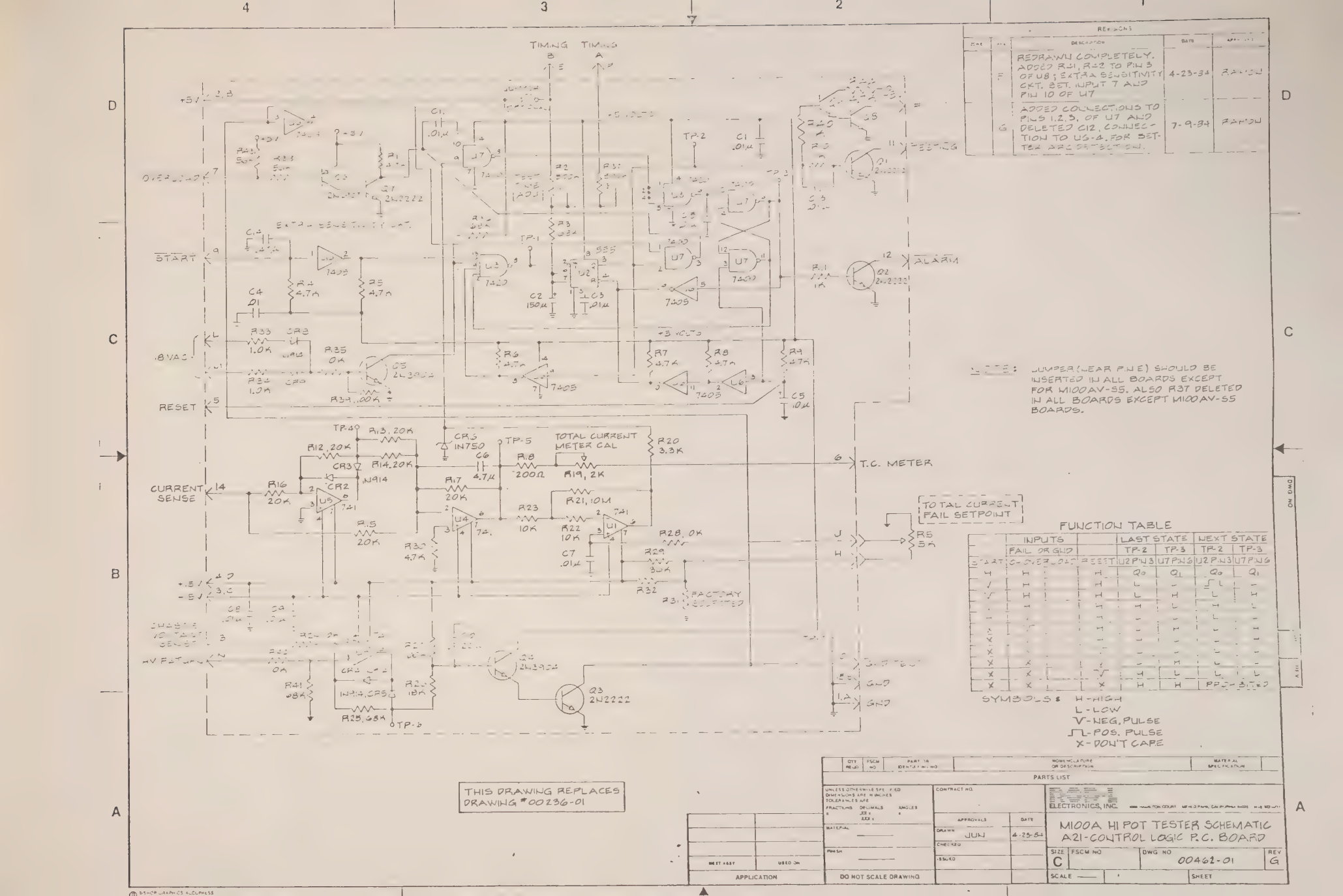
FINISH

ROD-L ELECTRONICS

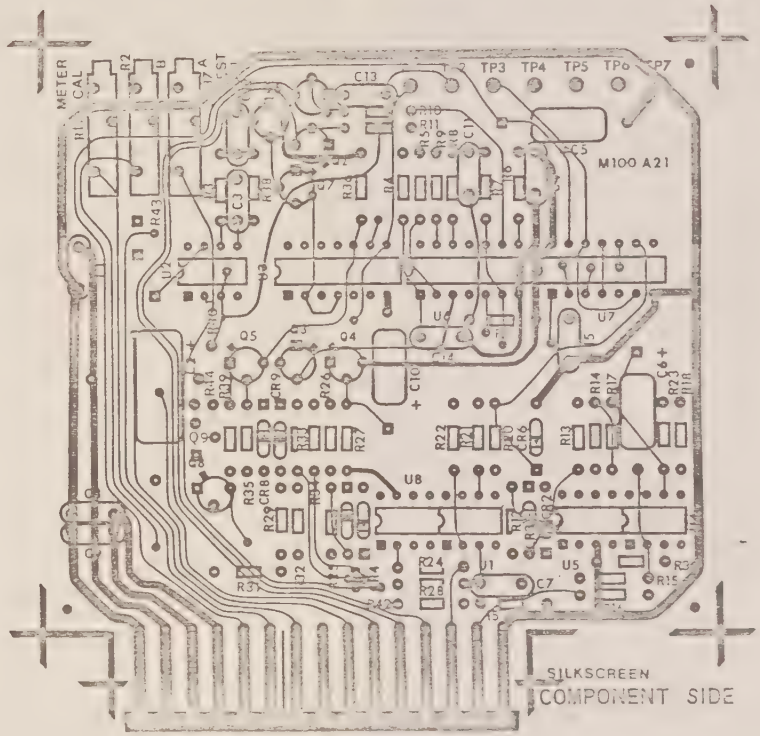
TITLE: A10 - POWER SUPPLY ASSEMBLY DRAWING

SIZE: C | DRAWING NO: 00459-02 | REV: A

SCALE: 2x | SHEET 1 OF 1


REVISIONS
ZONE | LTR | DESCRIPTION | DATE | APPROVED
F | REDRAWN COMPLETELY. ADDED R31, R32 TO PIN 3 OF U8; EXTRA SENSITIVITY CKT. SET. INPUT 7 AND PIN 10 OF U7 | 4-23-84 | RAMON
G | ADDED COLLECTIONS TO PINS 1,2,3, OF U7 AND DELETED C12, CONNECTION TO U5-4. FOR SETTER ARC SET ON. | 7-9-84 | RAMON
TIMING B
TIMING A
+5 VOLTS
OVERLOAD
START
RESET
18 VAC
CURRENT SENSE
HV RETURN
CHASSIS TO TANK SENSE
ALARM
T.C. METER
TOTAL CURRENT FAIL SETPOINT
TOTAL CURRENT METER CAL
FACTORY SELECTED
NOTE: JUMPER (NEAR P.N.E) SHOULD BE INSERTED IN ALL BOARDS EXCEPT FOR M100AV-55. ALSO R37 DELETED IN ALL BOARDS EXCEPT M100AV-55 BOARDS.
FUNCTION TABLE
INPUTS | LAST STATE | NEXT STATE
FAIL OR GND | TP-2 | TP-3 | TP-2 | TP-3
START | OVERLOAD | RESET | U2 P.N 3 | U7 P.N 6 | U2 P.N 3 | U7 P.N 6
SYMBOLS: H-HIGH L-LOW V-NEG. PULSE ⎍-POS. PULSE X-DON'T CARE
THIS DRAWING REPLACES DRAWING #00236-01
PARTS LIST
QTY REQ'D | FSCM NO | PART OR IDENTIFYING NO | NOMENCLATURE OR DESCRIPTION | MATERIAL SPECIFICATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS ANGLES .XX ±.02 .XXX ±
MATERIAL
FINISH
CONTRACT NO.
APPROVALS | DATE
DRAWN JUN | 4-25-84
CHECKED
ISSUED
DO NOT SCALE DRAWING
ELECTRONICS, INC.
M100A HI POT TESTER SCHEMATIC
A21-CONTROL LOGIC P.C. BOARD
SIZE C | FSCM NO | DWG NO 00461-01 | REV G
SCALE | SHEET
NEXT ASSY | USED ON
APPLICATION

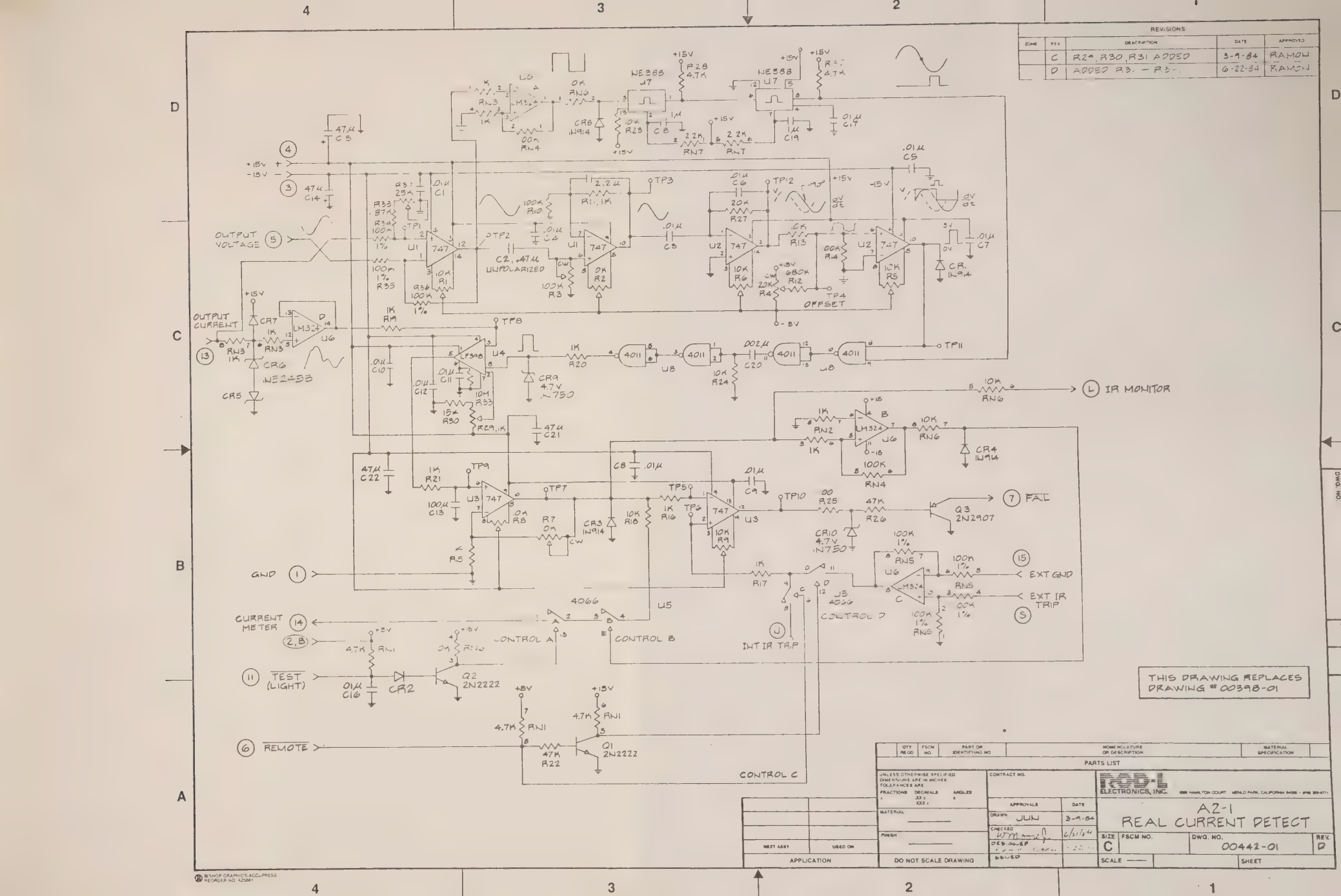
REVISIONS



PADMASTER - COMP SIDE VIEW

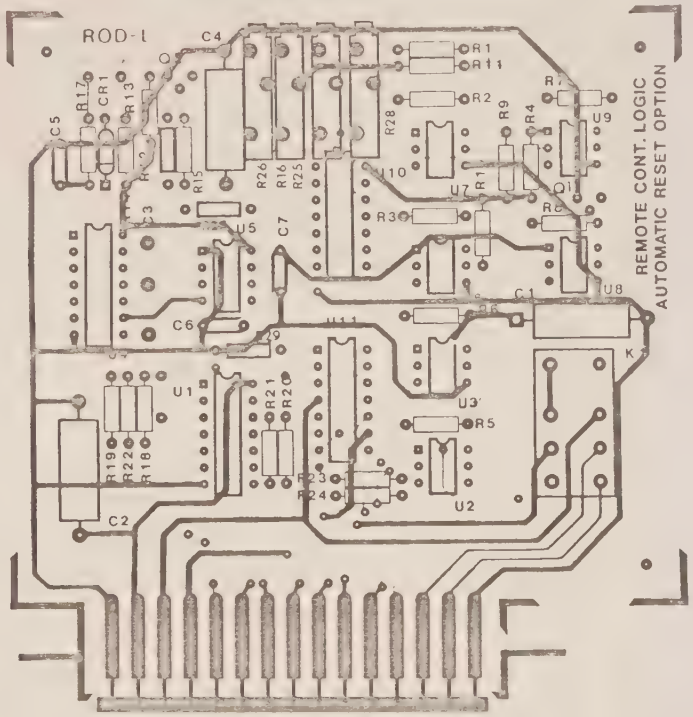
PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS .X ±.1 .XX ±.01 .XXX ±.005 ANGLES ±1°	CONTRACT NO.	RSI ELECTRONICS, INC.	
	APPROVALS / DRAWN JUN	DATE 8-24-83	A21-CONTROL LOGIC BOARD ASSEMBLY DRAWING
MATERIAL	CHECKED		SIZE C / FSCM NO / DWG NO 00462-02 / REV G
FINISH	ISSUED		SCALE 2X / SHEET
NEXT ASSY / USED ON: APPLICATION	DO NOT SCALE DRAWING		


REVISIONS
ZONE | REV | DESCRIPTION | DATE | APPROVED
C | R24, R30, R31 ADDED | 3-9-84 | RAMON
D | ADDED R3. - R3- | 6-22-84 | RAMON
OUTPUT VOLTAGE
OUTPUT CURRENT
GND
CURRENT METER
TEST (LIGHT)
REMOTE
IR MONITOR
FAIL
EXT GND
EXT IR TRIP
INT IR TRIP
OFFSET
CONTROL A
CONTROL B
CONTROL C
CONTROL D
THIS DRAWING REPLACES DRAWING # 00398-01
PARTS LIST
APPLICATION
DO NOT SCALE DRAWING
ELECTRONICS, INC.
AZ-1
REAL CURRENT DETECT
SIZE C | FSCM NO. | DWG. NO. 00442-01 | REV. D
SCALE | SHEET

ZONE	LTR	DESCRIPTION	DATE	APPR.

REDUCE TO 5.500±.002



QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE.
FRACTIONS ± DECIMALS XX ± XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

NEXT ASSY | USED ON
APPLICATION

CONTRACT NO.

APPROVALS	DATE
DRAWN LE	4/84
CHECKED	

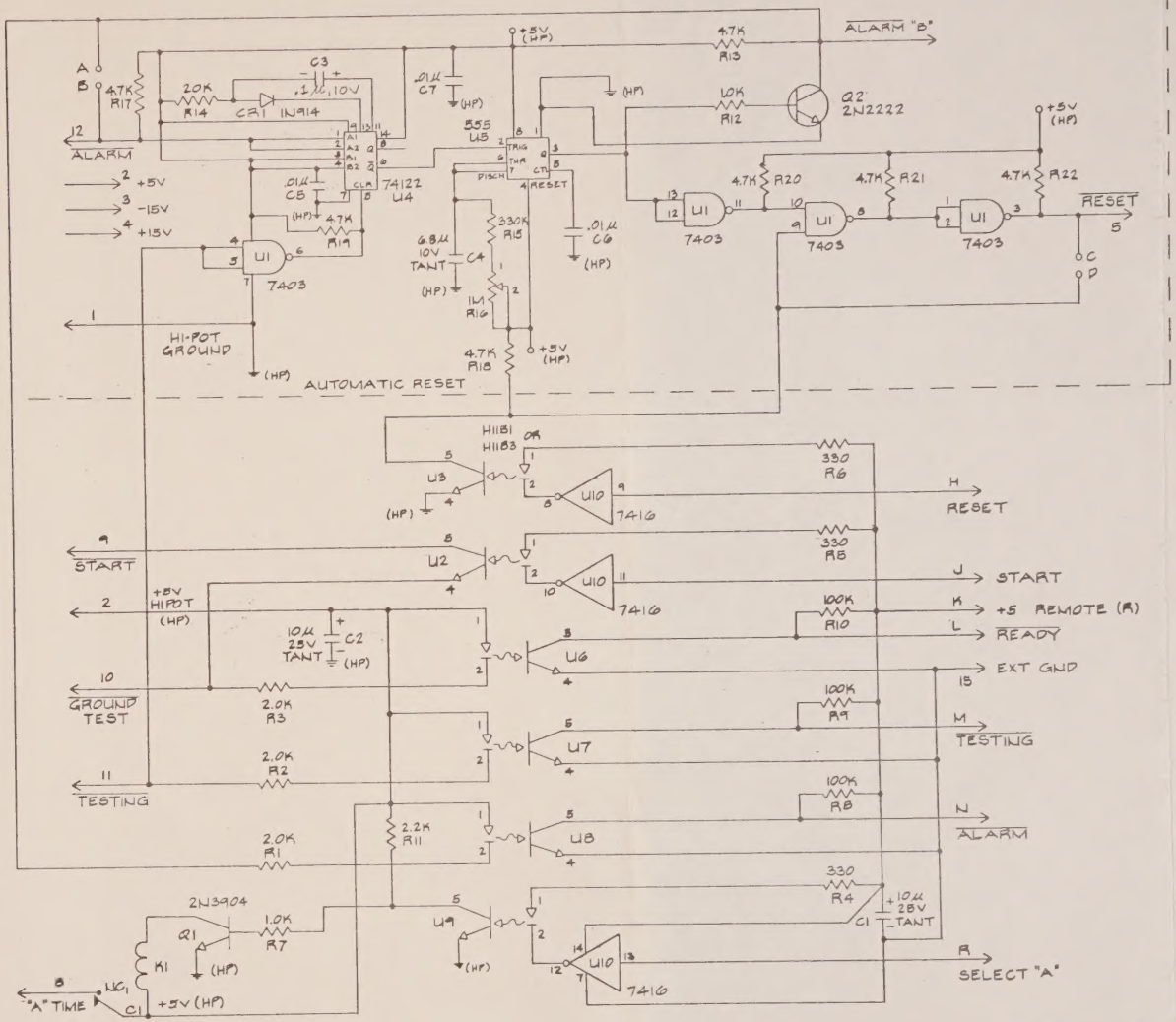
ROD-L ELECTRONICS, INC

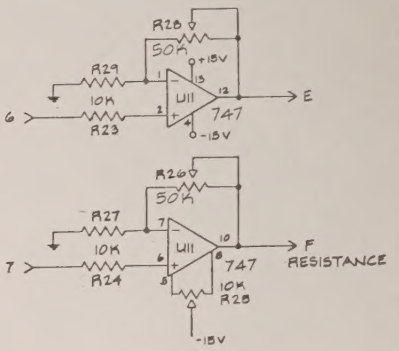
AB REMOTE / AUTO RESET ASSEMBLY DRAWING

SIZE	CODE IDENT NO	DRAWING NO	REV
C		00445-02	F

SCALE 2X | SHEET 1 OF 1

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	F	CHANGED REV. LEVEL TO AGREE WITH FABRICATION & ASSEMBLY DRWGS.	4-23-84	BILL





NOTES:

1. TO BYPASS AUTOMATIC RESET CIRCUITRY
   A. ADD JUMPERS A,B;C,D
   B. DELETE COMPONENTS:
      U1, U4, U5
      C3, C4, C5, C6
      CR1
      Q2
      R12 - R22
2. TO BYPASS MONITORING DELETE COMPONENTS:
      U11
      R23 - R29
3. FOR GND TESTER DELETE K1 USE MONITORING

THIS DRAWING REPLACES DRAWING # 00276-01.

QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

NEXT ASSY | USED ON

APPLICATION

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CONTRACT NO.

APPROVALS	DATE
DRAWN JUN	3-14-84
CHECKED	4/11/84
DESIGNED	
ISSUED	

ROD-L ELECTRONICS, INC. 1098 HAMILTON COURT - MENLO PARK, CALIFORNIA 94025 - (415) 323-0711

REMOTE CONTROL LOGIC WITH AUTOMATIC RESET OPTION

SIZE	FSCM NO.	DWG. NO.	REV.
C		00445-01	F

SCALE —— SHEET

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A2561

MP MASTER
MA32720